Centro de Economia e Finanças da UPorto

CEF.UP Working Paper
2011-03

WELFARE-IMPROVING GOVERNMENT BEHAVIOUR AND INEQUALITY - INSPECTION USING A HETEROGENEOUS-AGENT MODEL

Miguel Viegas
and
Ana Paula Ribeiro

Centro de Economia e Finanças da UP
www.fep.up.pt

Welfare-improving Government Behaviour and Inequality - Inspection Using a Heterogeneous-agent Model

Miguel Viegas
GOVCOPP, DEGEI, Universidade de Aveiro*
Ana Paula Ribeiro
CEF.UP and Faculdade de Economia, Universidade do Porto†

May 1, 2011

*Email: mlbv@ua.pt - Adress: Campus Universitrio de Santiago, 3880-193 Aveiro
†Email: aribeiro@fep.up.pt - Adress: Rua Dr. Roberto Frias, 4200-464 Porto. CEF.UP, Centre for Economics and Finance at University of Porto is supported by the Foundation for Science and Technology (FCT), Portugal.

Abstract

Governments behavior is expected to be non-neutral in terms of impacts on both welfare and inequality. In spite of their multivariate form, a tentative assessment of such inequality impacts can be provided by using a general equilibrium model with heterogeneous-agents and where wealth and income distribution is determined endogenously.

Using a model capable of exploring the relationship between fiscal policy variables and the endogenous cross-section distribution of income, wealth, consumption and leisure, this paper produces a welfare and inequality analysis of several equilibriums resulting from different combinations of debt levels and of government budget variables. Moreover, such assessment is based on the empirical reality of the EU countries.

JEL Classification: E17, E60, H60, I30.

Keywords: government budget composition and debt, heterogeneous agent model, idiosyncratic shock, inequality, welfare.

1 Introduction

The aim of this paper is to study how government behaviour - regarding government size, expenditure composition and financing - impinges on welfare and, in particular, on inequality.

Apparently, government size and expenditure composition is expected to impinge, both directly and indirectly, on inequality. While transfers, subsidies and progressive tax systems correct for inequality directly, expenditure on the provision of public services such as education, health, or even R&D may, indirectly, affect inequality via the effects on earning abilities and growth (see, for instance Ayala et al. (1999), Chu et al. (2000), Smeeding (2000) and Afonso et al. (2008)). Several authors have also studied the relationship between the quality of public finances (size, expenditure composition, governance and legal framework) and growth (see, for a comprehensive review, Barrios and Schaechter (2008)) which, together with the vast amount of literature that relates growth with inequality (Tanzi and Chalk (2002), Scully (2008), Kuznets (1955), Barro (2000), Benabou (1996) and Benabou (2002), among others) provide intuition on the mechanisms through which fiscal variables may impinge on inequality.

Moreover, deficit financing, through taxes or debt issuing is not innocuous. Namely, when Ricardian equivalence fails, government indebtedness puts upward pressure on the real interest rate, improving relative wealth of the richer. On the other hand, debt lessens private sector credit constraints that are especially binding for the poorer, potentially improving welfare inequality.

Therefore, in this paper we built a general equilibrium model with heterogeneous agents capable of capturing, theoretically, the relationship between fiscal variables and inequality.[1] In particular, we build a close-economy micro-founded model based on Aiyagari and McGrattan (1998), also used in Floden (2001). This is a dynastic model that includes a continuum of infinitely-lived rational (optimizing) agents who are hit by idiosyncratic wage shocks in an incomplete capital market. In order to smooth consumption/leisure, private agents optimally accumulate savings in "good times" spending them during "bad times". The model also includes a government subject to a dynamic budget constraint and optimizing firms endowed with a neoclassical Cobb-Douglas productive function. Besides allowing for taxes levied on labour and capital, we further decompose government expenditure into transfers to private sector, and productive and unproductive spending. While productive expenditure is included in the production function and, through this channel, improves output, unproductive spending is utility-augmenting.

Our aim is to contribute to a better understanding of the channels through which the presence of government affects household's behavior and, consequently, overall welfare and inequality. Based on the welfare criterion presented in Floden (2001), and Aiyagari and McGrattan (1998), we conduct steady state welfare analysis across different government sizes, expenditure

[1] Seminal works using heterogeneous-agent models date from late 80s early 90s and were developed by Bewley (1983), Imrohoroglu (1989), Huggett (1993), Aiyagari (1995) and Krusell and Smith (1998). For a survey on heterogeneous-agents models, see Storesletten et al. (2009), Rios-Rull (1995), Ljungqvist and Sargent (2004) and Cagetti and Nardi (2008). For technical and mathematical aspects see Huggett (1993), Krusell and Smith (2006), Rios-Rull (1995) and Rios-Rull (1999).

composition and financing. Additionally, we explore the decomposition of the welfare effects according to the methodology proposed by Floden (2001) into the consumption/leisure level effect, the uncertainty effect and the inequality effect. As for the inequality effect, we further detail the analysis by computing the usual inequality Gini indexes on wealth (asset holdings), disposable income, consumption and leisure.

The rest of this paper is organized as follows. In section 2 we describe the model, define the social (aggregate) welfare criterion and the underlying welfare decomposition effects. The model is solved for alternative parameterization of fiscal variables, within a meaningful range of values observed for the European countries, and the main results are discussed thoroughly section 3. In section 4 we present the final remarks.

2 Model

The model is built from a standard growth model modified to include a role for government together with an uninsured idiosyncratic risk and liquidity/ borrowing constraints.

We modify the original models of Aiyagari and McGrattan (1998) and Floden (2001) by breaking up the government expenditure into productive and unproductive. The former is introduced in the utility function and the latter in the production function. We also use a different approach for the calibration of the idiosyncratic shock.

The model is described below, as composed by three sectors: households, firms and the government. Then, we present the main step for steady sate computation and, finally, we use the model to build and decompose the welfare measure.

2.1 Households

There is a continuum of infinitely-lived agents of unit mass who receive after tax wage payments, $\tilde{w}$, after tax interest from savings, $\overline{r}\tilde{a}$, and transfers, tr, from the government. Following Barro (1973), Floden (2001) and Floden (2003), we consider that besides private consumption, $\tilde{c}$, and leisure, l , unproductive government spending, g_u , also contributes to households' utility at decreasing returns and according to a parameter ϑ. In each period, agents are hit by idiosyncratic shocks, e_t , which determines the productivity level. Borrowing is allowed only up to a certain limit $\tilde{b}$ and complete capital market is ruled out. This implies that agents have to ensure themselves by saving during "good times" ($\tilde{a}_{t+1} - \tilde{a}_t > 0$) while, during "bad times", savings are negative ($\tilde{a}_{t+1} - \tilde{a}_t < 0$). Each agent is endowed with one unit of time and solves the double problem of choosing between labor and leisure, and between consumption and saving.[2]

In particular, each household solves the following optimization problem:

$$\max_{\tilde{c}_t, l_t, \tilde{a}_{t+1}} E\left[\sum_{t=0}^{\infty} \beta^t Y_t^{1-\mu}(u_1(\tilde{c}_t, l_t) + \vartheta u_2(g_{ut}))|\tilde{a}_0, e_0\right] \tag{2.1}$$

Subject to:

$$\tilde{c}_t + (1+g)\tilde{a}_{t+1} = \tilde{w}_t(1-l_t)e_t + (1+\overline{r_t})\tilde{a}_t + tr_t \ , \ \tilde{c}_t \geq 0, \ \tilde{a}_t \geq -\tilde{b} \tag{2.2}$$

[2]In order to stabilize the model we define the principal variables as percentage of output (Y). Namely we define: $\tilde{w}_t = \frac{\overline{w}_t}{Y_t}$, $\tilde{c}_t = \frac{c_t}{Y_t}$, $\tilde{a}_t = \frac{a_t}{Y_t}$, $tr_t = \frac{TR_t}{Y_t}$, $g_{ut} = \frac{G_{ut}}{Y_t}$, and $\tilde{b}_t = \frac{b_t}{Y_t}$.

The household's instant utility functions are specified as:

$$u_1(\tilde{c}_t, l_t) = \frac{\tilde{c}_t^{1-\mu} \exp(-(1-\mu)\zeta(1-l_t)^{1+\gamma})}{1-\mu} \quad (2.3)$$

where μ represents the degree of risk aversion, ζ is constant related to average labor supply, and $\frac{1}{\gamma}$ represents the labor supply elasticity, and

$$u_2(g_u) = \frac{g_u^{1-\mu}}{1-\mu} \quad (2.4)$$

The productivity shock e_t is an idiosyncratic shock that evolves stochastically over time according to the following process: the natural logarithm of e_t is represented by an AR(1) process with a serial correlation coefficient ρ and a standard deviation σ:

$$\log(e_t) = \rho \log(e_{t-1}) + \epsilon_t \quad (2.5)$$

2.2 Firms

The firms are characterized by a neoclassic production function. Output, Y, is produced using capital, K, labour, N, and productive government spending, G_p.

$$Y_t = F(K_t, N_t, G_{pt}) = (K_t)^{\alpha}(N_t)^{1-\alpha}(G_{pt})^{\eta} \quad (2.6)$$

Productive government spending is identified with the share of public gross investment on output, in line with Barro (1990) and Auschauer (1989),[3]

[3] R. Barro, in a seminal paper (Barro (1990)) incorporates a public sector into a simple, constant return model of economic growth. The ratio of real public gross investment to

and enters as an input to private production.

The parameters α and η represent, respectively, the output elasticities of private capital and productive government expenditure. The production function exhibits constant returns to scale over private inputs but increasing returns over all inputs. Assuming competitive markets of goods and inputs, private factors are paid according to their marginal productivity and output is exhaustively distributed. Thus:

$$\tilde{w}_t = (1 - \tau_t)\frac{F_N(K_t, N_t, G_{pt})}{Y_t} \tag{2.7}$$

$$\overline{r_t} = (1 - \tau_t)(F_K(K_t, N_t, G_{pt}) - \delta) \tag{2.8}$$

where τ is a proportional income tax rate levied on labour and capital and δ is the depreciation rate of capital.

2.3 Government

The government promotes both productive and unproductive expenditures, collects taxes and pays lump-sum transfers to households, facing the following budget constraint in real terms:

$$g_{ut} + g_{pt} + tr_t + (\overline{r}_t + 1)d_t - (1 + g)d_{t+1} = \tau_t(1 - \delta k_t) \tag{2.9}$$

where, g_{pt} , k and d_t represent respectively, public gross investment (productive expenditure), private capital and government debt as a percentage of

real GDP, which is assumed to correspond to a flow of services identified as the measure of infrastructure services enters directly to the production function.

output.

2.4 Asset Market Equilibrium

Finally, the expression (2.10) represents the asset market clearing condition when aggregate asset holdings, $\overline{a}$, equal private capital plus public debt. As before, all variables are expressed as a percentage of output.

$$\overline{a}_t = k_t + d_t \tag{2.10}$$

2.5 Solving the model

The consumer's problem is defined by the maximization of (2.1) subject to (2.2), (2.7), (2.8), (2.9) and (2.10).

For a given level of d, tr, g_u and g_p, the recursive competitive equilibrium of this economy is characterized by: (i) a tax rate τ, (ii) a vector of gross prices $\{r, \tilde{w}\}$, (iii) two time invariant-decision rules for asset holdings, $\tilde{a}_{t+1} = \alpha(\tilde{a}_t, e_t)$, and labour supply, $(1 - l_t) = h(\tilde{a}_t, e_t)$ and (iv) a stationary distribution of households across asset holdings and productivity shocks, $\lambda(\tilde{a}, e)$, such that (a) decision rules solve the household's problem, (b) the government budget constraint is fulfilled, (c) r and $\tilde{w}$ are competitive and (d) labor and asset markets clear:

$$N = \int e_t h(\tilde{a}_t, e_t)\, d\lambda \tag{2.11}$$

$$\int \alpha(\tilde{a}_t, e_t)\, d\lambda = k(r) + d \tag{2.12}$$

The expression $\int \alpha(\tilde{a}_t, e_t)\, d\lambda$ represents the demand for assets, whereas the right hand side stands for the supply of assets (private capital plus government debt) relative to output and expressed as a function of the interest rate.

The algorithm consists of the following steps: (i) start with an initial guess for N (aggregate labour supply); (ii) try a first guess for interest rate within some interval $[r_l, r_u]$; (iii) given the guesses for N and r, back out the private capital-to-output ratio, the after-tax wage and the tax rate, using the government budget constraint and the fact that input markets are perfectly competitive; (iv) compute time invariant decision rules for the asset holdings, labour supply and the stationary distribution using the finite elements technique as McGrattan (1996, 2003); (v) update interest rate using the bisection method (Aiyagari (1994)) until asset market clears and, finally, (vi) update aggregate labour supply, N until labour market clears.

2.6 Social welfare computation

The utilitarian social welfare, U, is defined as the solution of (2.1) across all households (i.e, conforming the stationart distribution):[4]

$$U = \int E_0 \sum_{t=0}^{\infty} \beta^t u(c_t, l_t, G_{ut})\, d\lambda(a, e) \tag{2.13}$$

The utilitarian social welfare increases with consumption, leisure or government unproductive expenditure. Since the utility function is concave, the

[4]The solution is represented by a sequence of consumption and leisure to eternity $\{c_t, l_t\}_{t=0}^{\infty}$.

utilitarian social welfare is influenced by the distribution, and then, higher inequality or uncertainty will reduce welfare.

In order to measure the impact of policy in welfare across steady states, we decompose, following Floden (2001), the total welfare into three particular effects: the insurance level effect, the inequality effect and the consumption effect.

Consider a policy change that moves an economy from steady-state A to steady-state B. The total welfare gain is measured as a percentage of lifetime consumption that households gain (or lose) in moving instantly from economy from A to B, and is defined by w_u in:

$$\int E_0 \sum_{t=0}^{\infty} \beta^t u((1+w_u)c_t^A, l_t^A, G_{ut}^A)\, d\lambda^A(a,e) = \int E_0 \sum_{t=0}^{\infty} \beta^t u(c_t^B, l_t^B, G_{ut}^B)\, d\lambda^B(a,e) \tag{2.14}$$

2.6.1 Insurance effect

The insurance effect explores the time dimension of the utility function concavity. In order to remove the inequality effect, we compare the average level of consumption, C, and leisure, L, with the average of the certainty-equivalent[5] corresponding levels, $\overline{C}$ and $\overline{L}$, defined as:

$$C = \int c\, d\lambda(a,e) \quad \overline{C} = \int \bar{c}\, d\lambda(a,e) \quad L = \int l\, d\lambda(a,e) \quad \overline{L} = \int \bar{l}\, d\lambda(a,e)$$

where the certainty-equivalent consumption and leisure bundle , $\bar{c}$ and $\bar{l}$,

[5]The certainty-equivalent levels of consumption $\bar{c}$ and leisure $\bar{l}$ represent the constant levels of consumption and leisure that would ensure an utility level equivalent to that expected under the uncertain utility flows in the future.

must solve, for each household:[6]

$$\sum_{t=0}^{\infty} \beta^t u(\bar{c}_t, \bar{l}_t, G_{ut}) = E_0 \sum_{t=0}^{\infty} \beta^t u(c_t, l_t, G_{ut}) \tag{2.15}$$

We define p_{unc} as the cost of uncertainty and calculate it from the difference (in percent of life-time consumption) between the utility evaluated at the average consumption and leisure, and that evaluated at the corresponding certainty-equivalence levels:.

$$\sum_{t=0}^{\infty} \beta^t u((1-p_{unc})C, L, G_{ut}) = \sum_{t=0}^{\infty} \beta^t u(\overline{C}, \overline{L}, G_{ut}) \tag{2.16}$$

We define, w_{unc}, as the insurance effect, associated with moving from A to B:

$$w_{unc} = \frac{1-p^B_{unc}}{1-p^A_{unc}} - 1 \tag{2.17}$$

If uncertainty increases, $\overline{C}$ decreases and moves away from C; therefore, p_{unc} increases. The insurance welfare effect will be negative ($w_{unc} < 0$) and, thus, a rise in uncertainty impacts negatively on global welfare.

2.6.2 Inequality effect

The inequality effect explores the space dimension of the utility function concavity. We now use the certainty-equivalence variables to remove uncertainty from welfare. We define the cost of inequality, p_{ine}, as the difference (in percent of life-time consumption) between the utility of average certainty-

[6]As pointed in Floden (2001) the last equation does not define a unique combination of $\bar{c}$ and $\bar{l}$. To get an unique combination, we opt to set leisure at the level chosen by each household at $t = 0$. A second option was to use the average leisure level of the whole economy. The results are very similar and don't affect the conclusions.

equivalence of consumption and leisure, and the utility evaluated at the corresponding certainty-equivalence levels. Then p_{ine} is equivalent to the level of consumption that people are willing to give up in order to promote an equal distribution of consumption and leisure across individuals, maintaining the same level of social welfare:

$$\sum_{t=0}^{\infty} \beta^t u((1 - p_{ine})\overline{C}, \overline{L}, G_{ut}) = \int \sum_{t=0}^{\infty} \beta^t u(\bar{c}, \bar{l}, G_{ut}) \tag{2.18}$$

As before, w_{ine} represents the inequality effect associated with moving from A to B:

$$w_{ine} = \frac{1 - p_{ine}^B}{1 - p_{ine}^A} - 1 \tag{2.19}$$

A more unequal welfare distribution will decrease the right side of (2.18) and raises p_{ine}. Thus a rise in inequality impacts negatively on global welfare ($w_{ine} < 0$). We complement w_{ine} with the usual Gini coefficients for wealth and disposable income. Naturally, such indexes will not always match w_{ine} in which composition reflects all sources of utility (consumption, leisure and unproductive government expenditure).

Instead of the simple formula presented in Floden (2001) our decomposition of w_u into w_{lev}, w_{unc} and w_{ine} (due to the inclusion of unproductive expenditures in the utility function) yields a much more complex formula.[7]

[7] The formula is available upon request.

2.6.3 Consumption effect

Let the consumption level effect associated with moving from A to B be defined by:

$$w_{lev} = \frac{\hat{C}^B}{C^A} - 1 \tag{2.20}$$

where, $\hat{C}^B$, is the leisure-compensated consumption in economy B: the change in consumption necessary to reach the level of utility in B when L^A and G_u^A remain unchanged (Floden (2001)).

$$\sum_{t=0}^{\infty} \beta^t u(\hat{C}^B, L^A, G_u^A) = \sum_{t=0}^{\infty} \beta^t u(C^B, L^B, G_u^B)$$

2.7 Calibration

The model presented above follows closely Aiyagari and McGrattan (1998) and Floden (2001).

Preferences: μ, is set at 1.5, a value of standard use in the literature. For γ we follow, among others, Floden (2001) and set it to 2 which is equivalent to a wage elasticity of labour supply equal to 0.5. The parameter ζ determines the fraction of time devoted to labour and is set in order to match an average labour supply of around 0.3 ($\zeta = 9.145$). Finally, for the preferences towards public goods and services relative to private goods, the baseline calibration sets $\vartheta = 0.1$.[8]

[8] It is not usual to find g_u in utility in the literature. Moreover, when the utility function includes collective consumption, there is no homogeneous value for the calibration. For us, the use of values larger than $\vartheta = 0.1$ is not compatible with meaningful values for policy variables observed in EU and most of developed countries.

Technology: the production function is inspired in Barro (1990) to incorporate productive government spending. For our baseline model we follow Auschauer (1989) and set $\eta = 0.3$. For the capital share, $\alpha = 0.3$ (Aiyagari and McGrattan (1998) and Floden (2001)).

Discount factor and interest rate : according to our model, $r = \frac{\alpha}{k} - \delta$. We set $\delta = 7.5\%$ as in Aiyagari and McGrattan (1998). The variable k represents the capital-to-output ratio and the steady-state value is calibrated as to match the average value of the capital to output ratio of the EU15 countries (1990-2008).[9] Thus, with a period of one year, the steady-state value for the real interest rate yields 2.8%. We calibrate the discount factor in order to reach an equilibrium with this real interest rate level, which implies $\beta = 0.981$.

Government: the government is characterized by a set of fiscal indicators $\{d, tr, g_u, g_p\}$. Using the AMECO database, we calibrate policy variables with the average values (1990-2008) of the EU15. Specific values will be released during simulations in section 3.

The idiosyncratic shock: following the procedure of Tauchen (1986), the idiosyncratic shock is described as a first order Markov chain specification with seven states to match a first order autoregressive representation (Aiyagari (1994)).

Aiyagari (1994), Aiyagari and McGrattan (1998), and Floden (2001) base their values of ρ and σ (the serial correlation coefficient and the coefficient of

[9]Source: AMECO database, $k = 2.9$ for EU15.

variation) on empirical data for earnings and annual hours worked. Due to unavailable data on the EU15 average, we follow a different procedure. As in Rios-Rull et al. (2003) we set both parameters as to match the existent inequality in the EU15. Specifically, we use the income Gini index as a reference. According to the AMECO database (EU15 between 1990 and 2008) the income Gini index varies between 0.26 and 0.34. Thus we set $\rho = 0.8$ and $\sigma = 0.27$ which leads to a disposable income Gini index of around 0.28.

3 Optimal Government Expenditure and Financing

This section gives insight on optimal government size and financing. In particular we want to assess how fiscal policy variables $\{g_u, g_p, tr, d\}$ impinge on welfare as well as how they affect inequality. In order to make such assessment, we produce a continuum of steady state equilibria that are characterized by different government behaviours. First, we consider different endowments on each of the fiscal policy variables, allowing for a corresponding tax adjustment. Second, we evaluate the impacts of a changing composition on policy variables regarding fiscal policy inter-temporal structure: how do welfare and inequality indicators behave in face of more expenditure, financed through current taxes, relative to higher public debt? Third, for a given debt-to-output ratio, we study how a changing composition of government expenditure (intra-temporal substitution, for a fixed tax burden) impinges on welfare and inequality. Thus we find the optimal government composition of fiscal variables (both inter and intra-temporal) while assessing on how government expenditure and financing impacts on welfare inequality, as well as on several complementary inequality measures.

3.1 Individual impact of fiscal variables

In order to better understand the channels through which fiscal variables affect welfare and inequality, we calculate a sequence of steady state equilibria considering alternative values for a single variable, leaving the others unchanged. Throughout this exercises, taxes adjust to fulfill the government budget constraint and thus, also impact on welfare. However tax impacts on inequality are only indirect, namely through their effect on labour supply, as they are not progressive in the model.

3.1.1 Public debt: d

As a first exercise we propose to assess how debt impinges on welfare and inequality. In order to do that, we calculate the steady state equilibria for a continuum of debt-to-output ratios between 0 and 100%. We further decompose the welfare measure into the three effects (level, insurance and inequality). We also set other fiscal instrument, besides taxes, at $tr = 7.5\%$ and $g_u + g_p = 20\%$. The choice is somehow arbitrary, but nevertheless, these values are very close to the optimal levels obtained in the next exercises, and they are compatible with average values for the EU countries.

In a standard deterministic representative agent growth model, the impact of government debt on welfare depends on the tax regime. With lump-sum tax, debt is neutral, while with distorting tax, debt helps to smooth tax burden over time (Barro (1974, 1979); Aiyagari and McGrattan (1998)). In a heterogeneous-agent framework, government debt has an additional impact on welfare by providing further means to smooth consumption. By issuing debt, the government lessens agent's borrowing constraint (Aiyagari and McGrattan (1998)). Furthermore larger debt puts upward pressure on interest rates, making assets more profitable to hold and, thus, households become better insured against earning fluctuations. Naturally, higher debt (and interest rates) has also negative impacts on welfare by implying higher taxes and crowding-out private investment.

Figure 1 depicts the welfare assessment for different debt-to-output ratios, as well as its decomposition into level (w_{level}), insurance (w_{unc}) and inequality (w_{ine}) effects. As debt-to-output ratio increases, insurance increases (line with circles). For higher debt levels, the consumer's borrowing constraint is looser (Aiyagari and McGrattan (1998) show analytically why) and the interest rate is higher. Moreover, saving becomes more profitable and the insurance capacity improves. As for the welfare-level effect, higher debt-to-output ratios impinge negatively on consumption which rules out the over-accumulation of private capital beyond the golden rule level.[10] Finally the inequality effects (lines with crosses) are negative due to the interest rate increase which benefits more the asset owners relative to lower wealth classes, leading to a more unequal welfare distribution across households. Combining

[10]Except for the nonexistence of over-accumulation of private capital all the findings are in line with Floden (2001).

the three effects, the global welfare is hump shaped and peaks around $d = 50\%$.

Figure 2 provides information on how additional inequality measures change across debt-to-output ratios. The inequality measures reflect mostly the debt-to-output ratio effects on the interest rate and on the labour supply. By lessening credit constraints, debt reduces the layer of households with zero or negative asset position, improving the wealth distribution (the wealth Gini index decreases). According to Figure 2, the disposable income Gini index also moves negatively with debt. As debt increases, tax rate goes up affecting the after-tax wage. The substitution effect dominates in the labour market, but the elasticity of labour supply is higher among the wealthier who tend to switch more labour for leisure than the poorer. Therefore, the income Gini index decreases. Naturally, this effect in labour supply induces a more unequal distribution of leisure. Note finally that as interest rate rises with debt-to-output ratio, capital earnings contributes to a more unequal income distribution since wealthier households hold relatively more assets (despite the improved asset distribution). In balance, labour supply effect dominates and income dispersion improves with debt.

In spite of the improvement of income and asset holding distribution, we have just seen that the overall inequality effect contributes negatively to welfare (Figure 1 above). This example shows how difficult it may be to find adequate definitions and measures of inequality. A theoretical model, with a welfare function completely defined, enables a comprehensive identification of the three relevant sources of welfare inequality: consumption, leisure and unproductive expenditures (collective consumption):$\{c, l, g_u\}$. Collective consumption is not relevant because it is defined as a fraction of output distributed equally across households. As debt increases, consumption becomes more equally distributed in line with the disposable income and the asset holding. However, leisure distribution becomes more unequal, as a counterpart of the stronger fall of labour supply by the wealthier. In balance, the increase in leisure inequality dominates over improved distribution of consumption for higher debt-to-output ratios.

3.1.2 Social Transfers: tr

Consider now the impact of transfers, assuming constant debt of 50% and $g_u + g_p = 20\%$. Figure 3 shows how insurance (line with circles), consumption level (line with asterisk) and inequality (line with crosses) affect welfare across different transfer-to-output ratios. It is clear that larger transfer-to-output ratios impinge negatively on welfare level, reflecting lower labor supply and savings. Insurance and inequality effects are positive. Larger social transfers mean that, independent of the idiosyncratic shock, a larger portion of income is granted, and, thus uncertainty is lower. Lump-sum social transfers benefit all population, but the poorest benefit proportionally more because they hold a lower amount of assets. Therefore, the inequality effect on welfare is positive with transfers. Combining the three effects, total welfare measure maximizes for $tr = 8\%$.

For a closer inspection on the impacts on inequality, Figure 4 show how the Gini coefficients on asset holdings, disposable income, consumption and leisure, change across transfer-to-output ratios. Concerning wealth distribution, the Gini index is larger (higher inequality) for larger transfer-to-output ratios. Transfers, by reducing the need for insurance, affect especially asset holdings of the poorer: the fraction of households with negative or no wealth increases and the asset distribution becomes flatter. The effects on disposable income inequality are direct: transfers represent a lump sum element that make disposable income more homogeneous across households.

As stated before, overall inequality effect is positive while wealth and income inequality move in opposite ways with transfers. Apparently, disposable income effect on inequality dominates to reduce consumption inequality (Figure 4). In contrast to debt, leisure inequality decreases the larger the transfer-to-output ratio is; as transfers rise, the poorer face stronger disincentive to work, increasing leisure relatively to the wealthier. Concerning the two main sources of welfare inequality, both consumption and leisure distribution improves with larger transfers, making overall inequality (Figure 3) welfare enhancing.

3.1.3 Productive and unproductive expenditures: g_p, g_u

Unproductive spending, g_u affects welfare directly as it delivers utility for private agents (e.g. public health education or law and order). In the following exercise, we set $d = 50\%$, $tr = 7.5\%$ and $g_p = 1.5\%$. As before, we calculate the steady state equilibria for a continuum of unproductive government expenditure in percentage of output (between 8.5% and 18.5%).

Figure 5 plots total welfare as well as its components against government unproductive spending as percentage of output. The welfare level effect is positive for small increments of government expenditures. This means that, as explained in Aiyagari and McGrattan (1998) and Floden (2001), there is an over-accumulation of capital beyond the gold rule level which maximizes consumption. From about 10% of government spending, the distortion effect on labour and saving choices[11] dominates and the level effect turns negative. As for inequality and uncertainty, they both have a slight positive effect on welfare as government spending increases. Government delivers a constant (certain) flow of utility to households, reducing uncertainty. As for inequality, the mechanism is also direct - a larger endowment of public services is distributed evenly across households, reducing disparity in welfare. Combining the three effects, the global welfare reaches a maximum for a government unproductive expenditure of 12%. The importance of both these effects depends crucially on the value for the utility parameter concerning the unproductive government expenditure $\vartheta = 0.1$. Notice that the model is not capturing positive indirect effects in welfare and inequality from public services (namely those on growth resulting for instance from human capital accumulation) nor those affecting the idiosyncratic shock.

Figure 6 illustrates several inequality measures for different values of unproductive spending (as % of output). As with debt, disposable income and wealth (and thus, consumption) become more evenly distributed. The decrease of the wealth Gini coefficient reveals that asset selling affects more the wealthier, who are in a more favorable condition to smooth consumption and leisure.

The disposable income Gini index decreases because of the dominance of the labour supply elasticity effect. Figure 7 plots labour supply across asset

[11]due to the increased tax needs to finance the government expenditure increment.

holdings for the two extreme values of government expenditures ($g_u = 8.5\%$ and $g_u = 18.5\%$). For larger values of g_u, after-tax wage becomes smaller and the wealthier will work less relative to the poorer. Thus, labour income becomes more equally distributed. Naturally, the opposite occurs with leisure in which distribution becomes less compressed (i.e. more unequally distributed) -see Figure 6 . Unlike debt, consumption inequality positive effects slightly dominate over leisure and overall inequality has a modest positive impact on welfare as g_u rises.

The same exercise with the productive expenditure g_p reveals a positive level effect on welfare due to the improved productivity but with no impact on inequality. Table 1 resumes the individual effects of the policy variables on each inequality measures.

3.2 Optimal combination of social transfer, government spending and debt

In this context, a first question arises: is the (inter-temporal) composition of government expenditure financing meaningful to welfare and inequality? As government expenditure increases, does improving welfare precludes more tax-financed government expenditure or is public debt accumulation better? In the present section our exercises consist of assessing the optimal combination of debt, taxes and transfer for different levels of government spending.

In the present exercise we consider three government expenditure sizes: large, $\{g_u + g_p = 0.20\}$, medium, $\{g_u + g_p = 0.175\}$ and small, $\{g_u + g_p = 0.15\}$, values taken among those observed for some groups of EU countries.

For each government expenditure size we compute steady states across a continuum of debt levels $[0, 1.5]$ and transfer levels $[0, 0.15]$ (all values are expressed in percent of output). Then we repeat the simulation under the extreme scenario ($\vartheta = 0$) as in Aiyagari and McGrattan (1998) and Floden (2001). Table 2 sums up, for each scenario, the optimal debt and transfer combination, the corresponding welfare value and the inequality indicators.

Irrespectively of ϑ, as government expenditure size increases, the optimal level of public debt increases while social transfers remain rather stable. The optimal level of debt for the small, medium and large government expenditure-sizes is of 0%, 10% and 30%, respectively, when g_u is utility enhancing (otherwise, the values are higher, of 20%, 40% and 50%, respectively). The simulation shows that, for larger government expenditure, financing should be done, at least partially, through higher indebtedness.

The optimal public debt level rises with government expenditure-size to compensate for the utility loss associated with larger public spending. Transfers end up being less elastic with expenditure size than debt because the latter implies smaller tax distortions (lower tax effort). As such, government expenditure impinges negatively on welfare inequality. The insurance effect is welfare enhancing (due to the increased level of interest rate) while the level effect depresses welfare. Tax and interest rates raise as government expenditure and debt increase. Inequality measures reflect mostly the debt effect. According to the results in Table 2, wealth, income and consumption Gini coefficients decrease and the leisure Gini index increases.[12] Unproductive

[12] The exception concerns the income Gini index with $\vartheta = 0$ and $g_u + g_p = 17.50\%$: it rises lightly because transfers decrease from 9 to 8%.

government expenditure distorts incentives significantly, especially beyond a certain value.[13] Debt, in which distortion effect is much smaller, can accommodate part of government spending increase. The tax increase necessary to finance the growing expenditure affects labour and saving decisions. Households will supply less labour, specially the upper wealth classes, compressing the income distribution and pushing up the leisure Gini coefficient.

3.3 Optimal composition of global government spending

We have concluded that the larger the size of government, the higher the optimal debt-to-output ratio is. However, this is achieved at higher inequality and welfare costs. A final exercise consists in assessing the welfare and inequality impact of intra-temporal composition of government expenditure (g_u, g_p and tr). In the following exercises, inter-temporal government financing is given and, thus, we set aside the impacts on taxes and the corresponding second-order effects on leisure and income inequality operating through the labour supply channel. For a given debt level (for all exercises we set a public debt output ratio of 50%), optimal or not, one should expect expenditure composition to affect welfare and, in particular, welfare inequality. Moreover we consider different government sizes as measured by total spending:[14] a large-size government with $G = 30\%$ (of output); a medium-size government with $G = 25\%$ and a small-size government with $G = 20\%$.

[13] About 12% with a debt output ratio of 50% and a transfer output ratio of 7.5% as we saw, above, in figure 5.

[14] $G = g_u + g_p + tr$.

3.3.1 Unproductive expenditure(g_u) *versus* social transfers (tr)

Given a ceiling for total expenditure, for each government size, we first substitute unproductive expenditure by social transfer while productive expenditure remains constant ($g_p = 1.5\%$). Figure 8 and Table 3 illustrate the welfare effects and several inequality indexes as the weight of transfer in total expenditure rises, for the medium-size government ($G = 25\%$). The patterns are similar for the other government sizes.

The global welfare, which reflects the combination of the three effects described above, reaches a maximum with a specific combination of social transfers and unproductive expenditure (see table 4 for the optimal values). As we substitute unproductive expenditure by transfers, the welfare decomposition shows slight positive effects on equality and insurance. The hump-shaped welfare curve is mostly determined by the welfare level effect. For lower unproductive-expenditure (g_u), the household compensates with higher private consumption in order to keep the same level of utility. Thus, the level effect is positive and increasing. However, for a certain high level of transfers, the disincentive to work induced by higher transfers dominates and the level effect decreases (agents work and save less depressing the output).

Table 3 shows that the welfare inequality effect is positive and that it increases steadily as unproductive expenditure is substituted by transfers. Such inequality impact reflects the dominant effect of social transfers (see Table 1). Concerning the other inequality measures, Table 3 also shows that higher social transfers with less unproductive expenditure leads to higher wealth inequality (agent save less globally, especially the poorer). The disposable income and consumption inequality decrease due to the direct effect of social transfers. The fall in the leisure Gini index indicates that the reduction in labour supply induced by higher transfer payments affects especially the poorest.

Table 4 shows the optimal combination of unproductive expenditure with social transfers for different government sizes and compares the respective steady state equilibrium. The optimal levels of g_u are rather stable across government sizes while the level and weight of transfers changes significantly with government size. For the large-size government, transfers represent 50% of total expenditure while in small-size governments represents 30%. This means that the marginal rate of substitution of government expenditure for social transfer rises with the size of government. Moreover, the model points to a minimum unproductive expenditure-to-output ratio that households wish to keep.

Small-size governments exhibit higher global welfare performance, strongly determined by welfare level effects. Decreasing unproductive expenditure delivers significant efficiency gains and, consequently, positive welfare level effects due to the decrease of the optimal levels of g_u and tr. However, lower government-size has a negative impact on the insurance and inequality welfare effects especially due to the lower optimal transfer levels.

Concerning the inequality measures, we have already seen that the welfare distribution is inversely related to government size. Gini indexes presented in Table 4 support this result. With the exception of the wealth Gini index, all the remaining measures increase with smaller-size government. The increase of inequality in disposable income and consumption reflects the positive relation between transfer intensity and government-size. As for leisure distribution, the answer to the increased inequality must be found in the labour market. The transfer reduction affects strongly the disposable income of the poorer (as they receive lower capital earnings), which, by enhancing the positive response of labour supply, increases the leisure Gini index for small government sizes.

3.3.2 Social Transfers (tr) *versus* productive expenditure (g_p)

In the following exercise we test several combinations of social transfers and productive expenditures, while the level of unproductive spending is kept constant ($g_u = 0.15$) across government sizes. Table 5 and Figure 9a exhibit the welfare and inequality measures for different combinations of $\{g_p, tr\}$ for $\eta = 0.3$ and large-size government ($G = 30\%$). Patterns are similar for other government dimensions.

Under the baseline parameterization, welfare increases permanently until social transfers are exhausted. From Figure 9a we can see that the level effect dominates through the productivity effect. Although it is not clear in the graph on Figure 9a, simulations show a negative effect on the insurance and inequality components of welfare, caused respectively by the fall of interest rate and by the transfers reduction. As transfers are substituted by public investment, households will work harder, save more and consume more (as output increases). Given that productive expenditure does not affect the distribution, the changes occurring in the inequality measures derive from the reduction of social transfers. Low transfer levels induce households, specially the poorer, to engage in larger precautionary savings, decreasing wealth Gini index. On the other hand, all other inequality measures worsen because transfer reduction impinges directly on income and consumption distribution. Moreover, transfers reduction increases labour supply, especially for the poorer and, thus, leisure Gini index increases.

However, results depend crucially on the output elasticity relative to productive expenditure. Figure 9b takes $\eta = 0.03$ for the large-size government-case. In this case, the productivity effect is much weaker, and the welfare level gain is not sufficiently high to compensate for the negative effect on insurance and inequality. Welfare is maximized with a combination of $g_p = 3.50\%$ and $tr = 11.50\%$ (Table 6). The dynamics are similar except for the fact that the efficiency effect of the productive expenditures is not as high as in the baseline scenario. Above a certain level, productivity gains can no longer compensate for the utility loss due to lower transfers. As predictable, all inequality measures present the same patterns regardless the productivity of government expenditure (η).

Table 6 shows the optimal combination of productive expenditure with social transfers for different government sizes and resumes the main welfare and inequality measures for the (meaningful) lower level of output elasticity relative to productive expenditure ($\eta = 0.03$). As government-size decreases, both optimal levels of productive expenditure and social transfers decrease. But clearly, the optimal level of social transfer plunges deeper while the optimal level of productive expenditure declines marginally. The share of productive expenditure on total expenditure moves increases with the lower government-size, from 11.67% for $G = 30\%$ to 15.50% for $G = 20\%$. As for social transfer the share is 38.33% and 9.5%, respectively for the large and small sizes government. The welfare decomposition shows, for lower government sizes, a positive level effect against a negative insurance and inequality effect (both explained by the substitution of transfers for productive expenditure). The global welfare is maximized with the small-size government especially due to the welfare level effect. Decreasing the global government spending with social transfers releases the tax burden and simultaneously stimulates the labour supply, delivering significant efficiency gains.

As for the other inequality measures, Table 6 shows that the wealth Gini index decreases with lower government sizes because, with low transfers, the poor must increase their savings. The other Gini indexes reflect mostly the effect of the reduction of social transfers which affect directly the disposable income and consumption distribution. The increase in the leisure Gini index reflects a positive effect on labour supply, more expressive for the poorer.

3.3.3 Unproductive (g_u) *versus* productive expenditure (g_p)

In order to assess the degree of substitution between g_u and g_p, we set tr to 7.5% and compute equilibria for a series of combinations of $\{g_u, g_p\}$. Figure 10 plots the welfare decomposition across productive expenditures, g_p, for $G = 20\%$. The patterns are similar for the other government sizes. Exchanging unproductive for productive expenditure induces a productivity welfare effect acting through the production function. The other two components of welfare decomposition are completely neutral. Note that since productive and unproductive expenditures are equally distributed across the population, the former through the production function and the latter through the utility function, they are perfect substitutes regarding inequality. Table 10 shows, for $G = 20\%$, that the impact of substituting g_u for g_p is always welfare enhancing and has no impact on the inequality measures. The same applies for the remaining government sizes (medium and large).

4 Conclusion

Using a general equilibrium model with heterogeneous agents, calibrated according to the EU empirical reality, we exemplify the channels through which debt, social transfers, collective consumption and public gross investment affect social welfare. Moreover, we decompose the impact on social welfare into welfare-level, welfare-insurance and welfare-inequality effects. We complement the welfare-inequality effect by calculating Gini indexes on several standard inequality variables such as wealth, disposable income, consumption and leisure.

On one hand, we find that a rise in unproductive expenditure and in transfers improve welfare up until a certain upper bound. Direct effects on utility and disposable income, respectively, impinge positively on inequality and uncertainty, while indirect tax effects have negative impacts on the welfare level due to strong disincentives on labour supply. Productive expenditures induce a dominant positive welfare-level effect with no impact on inequality. On the other hand, debt delivers positive welfare-insurance effects through interest rate incentives on savings, but the dominance of this channel over the one that alleviates credit constraints impinges negatively on welfare inequality. Welfare-level effects are also negative due to the crowding-out effect and to the disincentive tax-effects on labor supply. Thus, welfare is also hump-shaped across debt-to-output ratios.

Concerning inter-temporal financing, we find that the optimal debt-to-output level rises with the size of government (as measured by the expenditures on output ratio) and, thus, implies larger inequality. Moreover, given government expenditure, optimal combination of debt and social transfer levels are smaller than the values observed, on average, in the EU countries, during the last decades.

Finally, for a given level of public debt and government size, we assess how (intra-temporal) composition of government spending impinges on both welfare and inequality: (i) substituting unproductive spending by transfers is welfare enhancing and improves disposable income inequality but only up to a lower bound of unproductive spending, rather inelastic; (ii) substituting unproductive by productive spending is always welfare enhancing and has no impact on any inequality measure; and (iii), shifting transfers for productive expenditure is always welfare enhancing for a sufficiently high output elasticity of public investment; if not, there is an optimal lower bound for social transfers. Since productive expenditure has no direct effects on inequality, transfers reduction impacts negatively on disposable income inequality.

The present paper relies only on steady state analysis, i.e., we do not account for a transition period, with welfare and related consequences in inequality in-between steady-states (for instance, during consolidation strategies). A second limitation is that the model also uses a closed economy, isolated from any foreign influence. We believe that the inclusion of more than one country, eventually with different-size countries, will bring more robustness to our results and also new insights. Finally, the absence of sovereign risk is also a simplification hypothesis which can overestimate optimal public debt levels.

Acknowledgements: We thank Alvaro Aguiar and Vincenzo Quadrini for valuable comments on this work.

References

Afonso, A., Schuknecht, L., and Tanzi, V. (2008). Income distribution: Determinants and public spending efficiency. *European Central Bank Working Paper Series*, 86.

Aiyagari, S. (1994). Uninsured idiosyncratic risk and aggregate saving. *Quarterly Journal of Economics*, 109(3):659–84.

Aiyagari, S. (1995). Optimal capital taxation with incomplete markets, borrowing constraints, and constant discounting. *Journal of Political Economy*, 103(6):1158–1175.

Aiyagari, S. R. and McGrattan, E. (1998). The optimum quantity of debt. *Journal of Monetary Economics*, 42(3):447–69.

Auschauer, D. A. (1989). Is public expenditure productive? *Journal of Monetary Economics*, 23(2):177–200.

Ayala, L., Martnez, R., and Ruiz-Huerta, J. (1999). Inequality, growth and welfare: An international comparison. *Luxembourg Income Study (LIS) Working Papers*, 215.

Barrios, S. and Schaechter, A. (2008). The quality of public finances and economic growth. *ECB Working Paper*, N 337.

Barro, R. (1973). The control of politicians: An economic model. *Public Choice*, 14(1):19–42.

Barro, R. (1974). Are government bonds net wealth? *Journal of Political Economy*, 82 (6):1095–1117.

Barro, R. (1979). On the determination of public debt. *Journal of Political Economy*, 87.

Barro, R. (1990). Government spending in a simple model of endogenous growth. *Journal of Political Economy*, 98(5).

Barro, R. (2000). Inequality and growth in a panel of countries. *Journal of Economic Growth*, 5:5–32.

Benabou, R. (1996). Inequality and growth. *NBER Macroeconomics Annual 1996, Ben Bernanke and Julio Rotemberg eds. MIT Press*, 11(74).

Benabou, R. (2002). Tax and education policy in a heterogeneous agent economy: What levels of redistribution maximize growth and eciency? *Econometrica*, 70:481–517.

Bewley, T. (1983). A diffculty with the optimum quantity of money. *Econometrica*, 51(5):1485–504.

Cagetti, M. and Nardi, M. D. (2008). Wealth inequality: Data and models. *Macroeconomic Dynamics*, 12(52):285–313.

Chu, K., Davoodi, H., and Gupta, S. (2000). Income distribution and tax and government social spending policies in developing countries. *International Monetary Fund Working Papers*, WP/00/62.

Floden, M. (2001). The effectiveness of government debt and transfers as insurance. *Journal of Monetary Economics*, 48(1):81–108.

Floden, M. (2003). Public saving and policy coordination in aging economies. *Scandinavian Journal of Economics*, 105(3):379–400.

Huggett, M. (1993). The risk-free rate in heterogeneous-agent incomplete-insurance economies. *Journal of Economic Dynamics and Control*, 17(5-6):953–69.

Imrohoroglu, A. (1989). Cost of business cycles with indivisibilities and liquidity constraints. *Journal of Political Economy*, 97(6):1364–83.

Krusell, P. and Smith, A. (1998). Income and wealth heterogeneity in the macroeconomy. *Journal of Political Economy*, 106(5):867–896.

Krusell, P. and Smith, A. (2006). Quantitative macroeconomic models with heterogeneous agents. In *Advances in Economics and Econometrics: Theory and Applications*. Blundell R, Newey W, T Persson. Cambridge: Cambridge University Press.

Kuznets, S. (1955). Economic growth and income inequality. *American Economic Review*, 49(1):1–28.

Ljungqvist, L. and Sargent, T. (2004). *Recursive Macroeconomic Theory*. MIT Press, Cambridge, MA.

McGrattan, E. R. (1996). Solving the stochastic growth model with a finite element method. *Journal of Economic Dynamics and Control*, 20.

McGrattan, E. R. (2003). The optimum quantity of debt: Technical appendix. *Annals of Economics and Finance*, 4.

Rios-Rull, J. (1995). Models with heterogeneous agents. In *Frontiers of Business Cycle Research*. edited by Cooley TF. Princeton, NJ: Princeton University Press.

Rios-Rull, J. (1999). Computation of equilibria in heterogenous agent models. In *Computational Methods for the Study of Dynamic Economies: An Introduction*. Edited by Ramon Marimon and Andrew Scott, Oxford University Press.

Rios-Rull, J., Castaneda, A., and Diaz-Gimenez, J. (2003). Accounting for earnings and wealth inequality. *Journal of Political Economy*, Vol. 111, no 4:818–857.

Scully, G. W. (2008). Optimal taxation, economic growth and income inequality in the united states. *NCPA Policy Report*, 316.

Smeeding, T. (2000). Changing income inequality in oecd countries: Updated results from the luxembourg income study (lis). *Luxembourg Income Study Working Paper*, 252.

Storesletten, K., Heathcote, J., and Violante, G. L. (2009). Quantitative macroeconomics with heterogeneous households. *Annual Review of Economics*, 1:319–354.

Tanzi, V. and Chalk, N. (2002). Impact of large public debt on growth in the eu: A discussion of potential channels. In *The behaviour of fiscal authorities. Stabilization, growth and institutions*, pages 186–211. Buti, M., J. von Hagen and C. Martinez-Mongay (eds.).

Tauchen, G. (1986). Statistical properties of generalized method-of-moments estimators of structural parameters obtained from financial market data. *Journal of Business & Economic Statistics, American Statistical Association*, 4(4):397–416.

TABLES

	d	tr	g_u	g_p
Wealth Gini	↘	↗	↘	=
Income Gini	↘	↘	↘	=
Consumption Gini	↘	↘	↘	=
Leisure Gini	↗	↘	↗	=
Welfare inequality	↗	↘	↘	=

Table 1: Inequality effect of fiscal policy variables.

	$\vartheta = 0.1$			$\vartheta = 0.0$		
$g_u + g_p$	0.15	0.175	0.20	0.15	0.175	0.20
d	0.00	0.10	0.30	0.20	0.40	0.50
tr	0.02	0.02	0.02	0.09	0.08	0.08
τ	0.2289	0.2624	0.2968	0.3200	0.3417	0.3742
r	0.0124	0.0139	0.0159	0.0178	0.0192	0.0211
WG	0.4814	0.4766	0.4697	0.4847	0.4768	0.4724
IG	0.3178	0.3165	0.3147	0.2811	0.2837	0.2814
CG	0.1471	0.1455	0.1431	0.1327	0.1321	0.1304
LG	0.0417	0.0422	0.0428	0.0412	0.0418	0.0421
w_u	0.0000	-0.0129	-0.0340	0.0000	-0.0409	-0.0814
w_{level}	0.0000	-0.0225	-0.0560	0.0000	-0.0449	-0.0981
w_{unc}	0.0000	+0.0017	+0.0041	0.0000	+0.0010	+0.0025
w_{ine}	0.0000	-0.0005	-0.0017	0.0000	-0.0016	-0.0018

Table 2: The optimal combination of debt, transfers and government expenditure for baseline calibration ($\vartheta = 0.1$) and for the alternative calibration ($\vartheta = 0.0$).
Notes: WG = Wealth Gini index - IG = Income Gini index - CG = Consumption Gini index - LG = Leisure Gini index.

g_u	tr	w_u	WG	IG	CG	LG	w_{ine}
0.2350	0.0000	0.0000	0.4574	0.3238	0.1440	0.0440	0.0000
0.2100	0.0250	0.0342	0.4635	0.3100	0.1399	0.0433	0.0021
0.1850	0.0500	0.0617	0.4690	0.2974	0.1361	0.0426	0.0038
0.1600	0.0750	0.0812	0.4740	0.2859	0.1324	0.0419	0.0053
0.1350	0.1000	0.0904	0.4786	0.2753	0.1289	0.0413	0.0066
0.1100	0.1250	0.0857	0.4829	0.2655	0.1256	0.0407	0.0077
0.0850	0.1500	0.0608	0.4868	0.2564	0.1224	0.0401	0.0086
0.0600	0.1750	0.0028	0.4904	0.2479	0.1193	0.0396	0.0092
0.0350	0.2000	-0.1212	0.4938	0.2400	0.1163	0.0390	0.0097

Table 3: Unproductive expenditure *versus* social transfers ($G = 25\%$).

	$G = 0.30$	$G = 0.25$	$G = 0.20$
g_p	0.0150	0.0150	0.0150
tr	0.1500	0.1050	0.0600
g_u	0.1350	0.1300	0.1250
τ	0.3981	0.3365	0.2732
r	0.0234	0.0197	0.0164
WG	0.4831	0.4795	0.4754
IG	0.2513	0.2732	0.2953
CG	0.1198	0.1282	0.1362
LG	0.0407	0.0412	0.0413
w_u	0.0000	0.0606	0.1148
w_{level}	0.0000	0.1663	0.3438
w_{ins}	0.0000	-0.0043	-0.0093
wi_{ine}	0.0000	-0.0041	-0.0098

Table 4: Optimal unproductive expenditure and social transfer combination across government sizes.

g_p	tr	w_u	WG	IG	CG	LG	w_{ine}
0.0050	0.1450	0.0000	0.4823	0.2531	0.1204	0.0408	0.0000
0.0100	0.1400	0.8668	0.4815	0.2550	0.1211	0.0409	-0.0003
0.0150	0.1350	1.7324	0.4806	0.2569	0.1218	0.0410	-0.0006
0.0200	0.1300	2.6115	0.4798	0.2588	0.1224	0.0411	-0.0009
0.0250	0.1250	3.5093	0.4789	0.2607	0.1231	0.0412	-0.0011
0.0300	0.1200	4.4280	0.4781	0.2627	0.1238	0.0413	-0.0014
0.0350	0.1150	5.3684	0.4772	0.2647	0.1244	0.0414	-0.0018
0.0400	0.1100	6.3310	0.4763	0.2667	0.1251	0.0416	-0.0021
0.0450	0.1050	7.3156	0.4754	0.2688	0.1258	0.0417	-0.0024
0.0500	0.1000	8.3222	0.4745	0.2709	0.1265	0.0418	-0.0027

Table 5: Productive expenditure *versus* social transfers: $G = 30\%$ and $\eta = 0.3$.

	$G = 0.30$	$G = 0.25$	$G = 0.20$
g_p	0.0350	0.0330	0.0310
tr	0.1150	0.0670	0.0190
g_u	0.1500	0.1500	0.1500
τ	0.3985	0.3369	0.2736
r	0.0229	0.0191	0.0157
WG	0.4772	0.4725	0.4670
IG	0.2647	0.2894	0.3148
CG	0.1244	0.1336	0.1424
LG	0.0414	0.0421	0.0426
w_u	0.0000	0.0135	0.0201
w_{level}	0.0000	0.0770	0.1502
w_{ins}	0.0000	-0.0050	-0.0109
wi_{ine}	0.0000	-0.0040	-0.0088

Table 6: Optimal productive expenditure and social transfer combination across government-sizes ($\eta = 0.03$).

g_u	g_p	wu	WG	IG	CG	LG	wine
0.1100	0.0150	0.0000	0.4781	0.2887	0.1340	0.0408	0.0000
0.1050	0.0200	0.2883	0.4781	0.2887	0.1340	0.0408	0.0000
0.1000	0.0250	0.5699	0.4781	0.2887	0.1340	0.0408	0.0000
0.0950	0.0300	0.8456	0.4781	0.2887	0.1340	0.0408	0.0000
0.0900	0.0350	1.1151	0.4781	0.2887	0.1340	0.0408	0.0000

Table 7: Unproductive *versus* productive expenditure ($G = 20\%$).

List of Figures

FIGURES

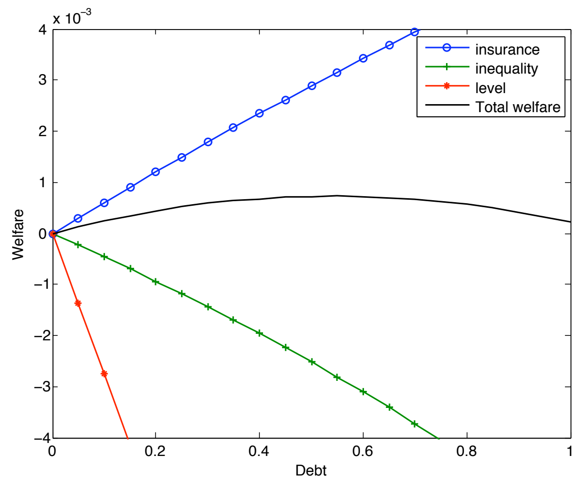


Figure 1: Welfare decomposition across debt-to-output ratios.

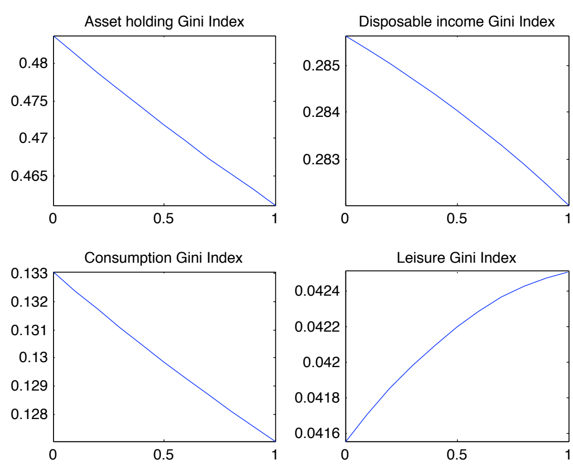


Figure 2: Gini indexes across debt-to-output ratios.

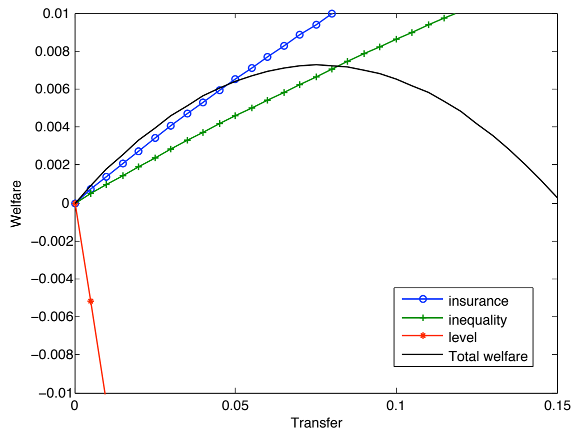


Figure 3: Welfare decomposition across transfer-to-output ratios.

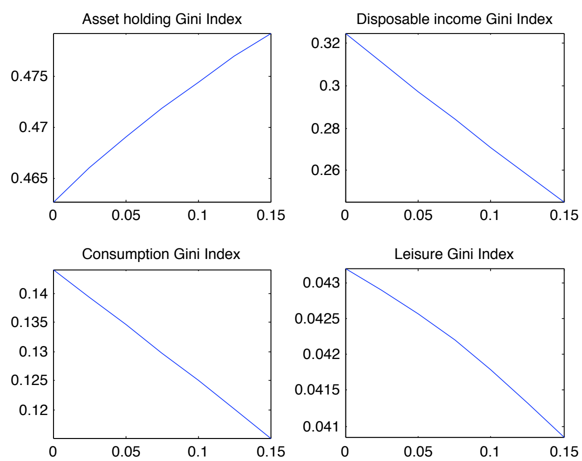


Figure 4: Gini indexes across transfer-to-output ratios.

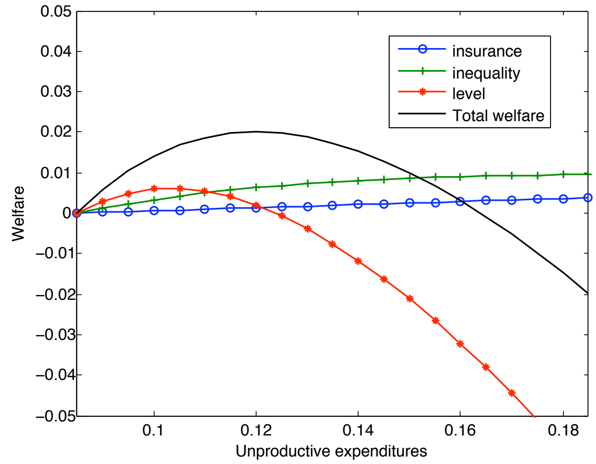


Figure 5: Welfare decomposition across unproductive government expenditure: g_u.

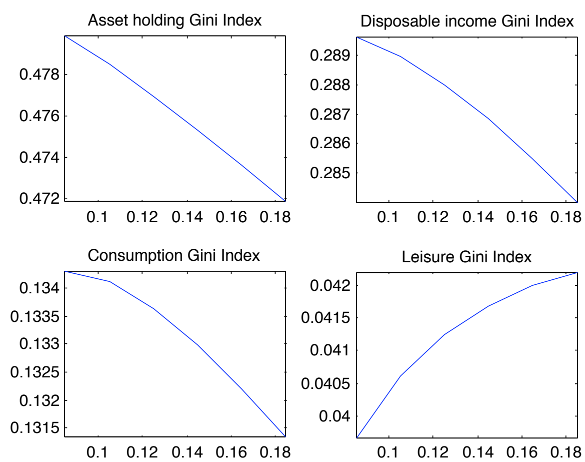


Figure 6: Gini indexes across unproductive government expenditure: g_u.

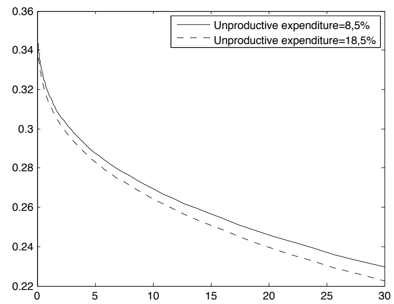


Figure 7: Labour supply (vertical axis) against wealth (horizontal axis).

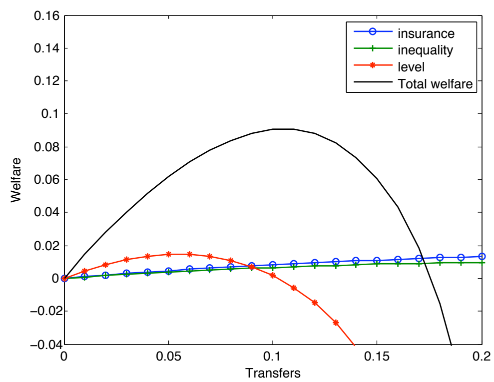
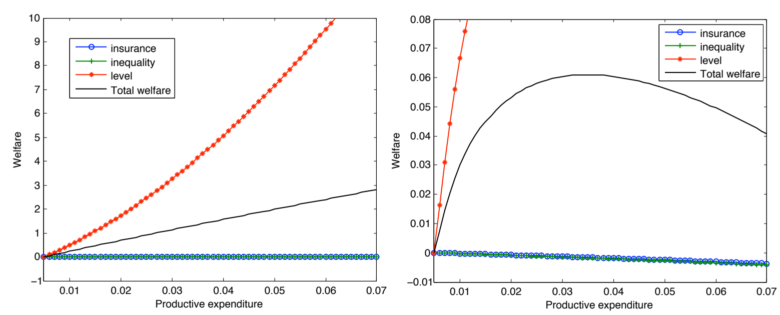


Figure 8: Welfare decomposition when social transfers substitute for unproductive expenditure ($G = 25\%$).



(a) $\eta = 0.3$ (b) $\eta = 0.03$

Figure 9: Welfare decomposition when g_p substitute for social transfers ($G = 30\%$).

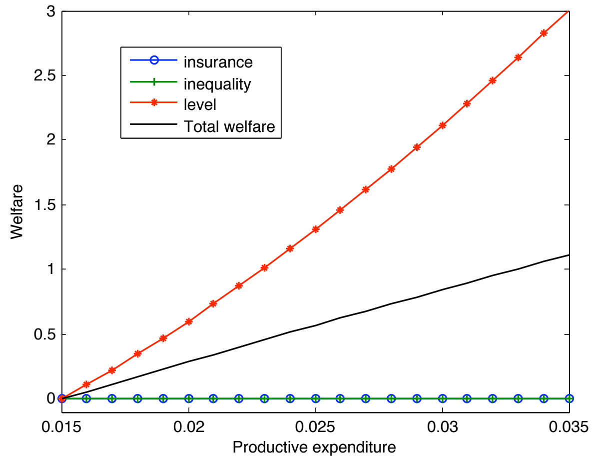


Figure 10: Welfare decomposition when productive expenditure substitutes unproductive expenditure ($G = 20\%$).