Imperfect Financial Markets and the Cyclicality of Social Spending*

Maren Froemel† Wojtek Paczos‡

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Abstract

This paper explores the link between default risk and fiscal procycliality. We show that countries with higher sovereign risk have a more procyclical fiscal expenditure policy, which is driven mostly by transfers. We build a small open economy model with income inequality, social transfers, and default risk to rationalize this fact. Without default risk transfers are countercyclical, inequality is procyclical, and external debt is used to smooth distortionary taxation. With default risk, transfers account for most of fiscal adjustment because taxation becomes costly for the government. Transfers become procyclical and inequality worsens during times when risk premia are high. We confirm the predictions of the model in the data: in recessions in economies with default risk, transfers take the bigger burden relative to government consumption, whereas the opposite is true in economies with low default risk.

Keywords: fiscal policy, default risk, income inequality, redistribution, emerging markets

JEL classification: E62, F34, F41

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†Corresponding author; Bank of England, Threadneedle St, London EC2R 8AH, United Kingdom, Maren.Froemel@bankofengland.co.uk.

‡Cardiff University and Institute of Economics, Polish Academy of Sciences.

1 Introduction

In stark contrast to developed economies, there is ample evidence that governments in emerging markets conduct *procyclical* fiscal policy. In this paper we explore the drivers of this phenomenon both empirically and theoretically.

The cross-country differences in fiscal expenditure cyclicality cannot be explained by government consumption, but rather are driven by differences in social transfers (Michaud and Rothert, 2018). We build a theory which links the two facts and show, that the borrowing costs faced by developing countries, especially during periods of financial distress, drive the procylicality of social transfers, which in turn accounts for the puzzling finding of the procyclical fiscal policy. In addition, emerging markets have a high reliance on external debt for financing fiscal expenditures and face countercyclical interest rates, meaning high borrowing costs during recessions exacerbate the financing problem.[1]

Our paper has two objectives. First, we contribute to the empirical literature on fiscal policy by evaluating the cyclicality of different fiscal expenditure components. We use a panel of advanced and emerging small open economies and calculate the average sovereign debt rating and the cyclicality of each fiscal expenditure category. We show that overall, fiscal expenditure cyclicality correlates negatively with the average rating (-0.54), which means that countries with safer debt enjoy more countercyclical fiscal expenditures. When divided into components, social transfers are very strongly correlated with the average rating (-0.72), while government consumption is not (-0.18). This means that government consumption is on average acyclical and does not depend on the average rating and that the changes in overall cyclicality are driven by social transfers.

Second, we propose a theory that links the cyclicality of the two components of fiscal expenditure to the sovereign risk. We build a small open economy model with endogenous default risk, heterogenous households, labor supply choice and active fiscal policy. There are two types of fiscal expenditures: a social transfers which are a perfect substitute to private income and government consumption; a public good which provides direct utility to households, but is not a substitute to private income. Households differ in their labor productivity. This inequality motivates lump-sum social transfers as a way to redistribute income. The government can finance its expenditures by taxation or by borrowing and

[1] See Reinhart and Rogoff (2011b), Kaminsky, Reinhart and Végh (2005) and Neumeyer and Perri (2005), Uribe and Yue (2006) for contributions to this literature.

saving in international financial markets. This is subject to two frictions: bonds are not state contingent and subject to default risk, because of limited enforcement. Taxes are distortionary because labor supply is elastic. The domestic economy is subject to persistent shocks to total factor productivity, so external financial markets are the only way to insure against aggregate income fluctuations.

When income inequality is non-negligible, the government effectively redistributes income using a positive tax rate and positive transfers. The degree of redistribution is limited by distortionary taxation, and the government trades off utility gains from equalizing consumption against output and welfare losses arising from taxation.

During periods of low output, it is more costly to use taxation to raise revenue and to redistributive income. With good access to financial markets, the government relies more on borrowing and lending abroad to raise revenue. Taxes fall in recessions and transfers increase. The increase in transfers happens for two reasons. First, total household income falls and the government tries to smooth all households' incomes over time. Second, income fluctuations are more costly for low income households, so countercyclical transfers shift more resources to poor households during recessions leading to procyclical consumption inequality. Public good consumption is procyclical and comoves with private consumption. Due to the countercyclicality of social transfers, the ratio of social transfers to government consumption is countercyclical.

Default risk limits access to financial markets because it lowers the price of debt issued by the government. The incentives to default are higher during recessions, as potential income losses from repayment are more costly because of risk aversion. As a result, the current account deficit will become smaller during an enduring recession. The government has less resources at its disposal, and cuts transfer and public good spending, because the welfare and output cost from taxation outweigh the insurance gains from counteryclical redistribution. Because of the deadweight losses from taxation, the government is willing to give up more of social transfers, which is a perfect substitute to private income and has no additional cost, while it still attempts to smooth public good spending. As a result, social transfers are cut more strongly than public good consumption, and the tax rate is increased. Thus, the ratio of social trasfers to public good consumption becomes procyclical. Thus, procyclical fiscal expenditure can be rationalized by countercyclical interest rates, and, in the absence of international financial institutions and bail out programs, emerges as the optimal policy prediction.

In times of debt crises, fiscal adjustment is indispensable in debtor countries. This paper contributes to the discussion using a parsimonious structural model with a trade-off between taxes and transfer spending. Tax increases lead to excessive welfare losses and output reductions, but social transfers cuts are also detrimental for welfare because of economic inequality. In this particular case of affine tax and transfer system, we show that both instruments are used for fiscal adjustment, but spending suffers from a more severe cut when external borrowing costs become high. Furthermore, higher inequality exacerbates the procyclicality of public spending, because marginal welfare losses from redistribution are higher and impede insurance policies in the absence of external insurance.

2 Literature

This paper contributes to and builds on the literature of optimal fiscal policy over the business cycle. Empirical literature since Gavin and Perotti (1997) study of Latin America has pointed out that fiscal policy emerging markets is, unlike in advanced economies, procyclical. Kaminsky et al. (2005) revisit the evidence and confirm the procyclical nature of fiscal policy in a comprehensively broad set of countries and extend the analysis to include monetary policy. They coin the term by which the phoenomenon of procyclical policies is oftern referred to: *when it rains, it pours.* They also emphasize that current accounts are countercyclical in developing countries. In our contribution current account turns countercyclical when the economy becomes prone to default, which in turn drives the procyclicality of social transfers. Végh and Vuletin (2015) build a dataset on tax rates and find that tax policy is acyclical in industrial countries but mostly procyclical in developing countries.

Our contribution is most closely related to Michaud and Rothert (2018), who show that fiscal procyclicality in emerging economies does not equally apply to all components of fiscal expenditure. In particular, social transfers are highly procycylical in emering and highly countercyclical in advanced economies, while public good consumption is mostly acyclical in both groups. They use a small open economy model to study the consequences of different cyclicalities of social transfers. We complement their study in two dimensions. First, we show that cyclicality of transfers correlates strongly not only with binary category of advanced/emering economy, but also with sovereign risk. Second, we provide a theory that can endogenously and quantitatively explains these observations.

Ours is not the first quantitative model that links cyclicality of fiscal policy with public debt and default risk. Cuadra, Sanchez and Sapriza (2010) build on the sovereign default model of Eaton and Gersovitz (1981), introducing endogenous production and distortionary taxes. They find that optimal tax policy becomes procyclical (tax rates rise in bad times) when the borrowing constraint starts binding while government expenditure does not depend on risk.[2] In a similar framework, Arellano and Bai (2017) introduce tax rigidity and show that tax hikes can prevent only "fiscal defaults" (happening due to liquidity constraints), but not aggregate defaults (happening due to resource constraints). Yet, raising taxes during a crisis can deepen the recession. We contribute to the literature by allowing for two types of fiscal expenditures with distinct roles. In our model, like in the data, the procyclicality of fiscal policy in risky economies is driven not only by procyclicality on the revenue side (taxes) but also by the procycality on the expenditure side (transfers), while governement consumption varies less.

The other strand of literature focuses on political economy frictions as a reason for procyclical fiscal policy. In Andreasen, Sandleris and Van der Ghote (2019), economic inequality and the progressivity of the tax system matters for the default decision of the government and determines debt sustainability, because spending cuts can only be made by a political agreement. A more unequal economy with regressive taxes will be less likely to accept strong fiscal tightening. Our contribution provides a complementary theory of the role of economic inequality in making countercyclical policies more costly to sustain. Talvi and Végh (2005) show how volatile tax revenues can translate into strongly procyclical government expenditures when governments face political pressure to run budget deficits and engage in excessive spending to their constituencies during booms. Ilzetzki (2011) shows that optimal transfers are procyclical when disagreement is sufficiently high. While in his model agents are homogeneous, we study transfers as an insurance and redistributive device in the presence of income inequality. Furthermore, the government in the model has commitment to repay its obligations, so it can borrow and save freely at the risk free rate.

Similarly to Ferriere (2015) we introduce inequality and endogenous tax progressivity into the sovereign default model, and we also find that more unequal (less tax progressive)

[2] In a similar vein, albeit in a different framework Camous and Gimber (2018) explain tax policy procyclicality by a coordination failure in a multiple equilibria world: if the inherited stock of debt is large enough households restrict their labour supply in anticipation of a high tax rate, which induces the government to set a high tax rate.

economies have higher inventives to default. We quantify this channel and find that this effect is numerically small. In a recent contribution Bianchi, Ottonello and Presno (2021) introduce Keynesian demand channe to study the trade off between fiscal stimulus (countercyclicality) and austerity (procyclicality). Our model studies a similar trade-off, albeit predeminantly on the supply side, with a three-way trade-off between efficiency, equality, and consumption smoothing. In our model not only debt, default and government consumption are decided endogenously but also taxes and transfers, which allows us to draw the difference between transfers-based and government-consumption based countercyclical policies.

There is a large literature on how default risk and countercyclical interest rates affect business cycle characteristics in emerging markets. Neumeyer and Perri (2005) and Uribe and Yue (2006) show that interest rates are highly counteryclical in emerging markets, and they can account for counteryclical current accounts and excess volatility in consumption.

3 Stylized Facts

In this section we present empirical evidence on the cyclicality of different components of government expenditure. Our contribution is to link the cyclicality of expenditure categories with the degree of sovereign risk. We show that the cyclicality government expenditures that have more of a transfer (or insurance) component varies significantly with sovereign risk and is a key determinant of procyclical fiscal policies in risky, emerging economies. For less targeted government expenditures (that have more of a public good character), cyclicality varies less with sovereign risk.

We merge data from several sources. We use data on detailed government expenditure and output from Michaud and Rothert (2018).[3] We complement this with the data on sovereign debt ratings and inequality from publicly available sources. The main dataset includes 30 countries, both emerging and developed, for the period of 26 years between 1990 and 2015 at an annual frequency.[4]

Total government expenditure is the sum of the use of goods and services (government consumption), transfer payments, compensation of employees, subsidies, and interest pay-

[3]They harmonize the Government Finance Statistics Dataset (GFS) by the IMF with the macroeconomic aggregates from the World Development Indicators (WDI) by the World Bank

[4]The sample has been selected based on the availability of the detailed expenditure breakdown, see Michaud and Rothert (2018) for details.

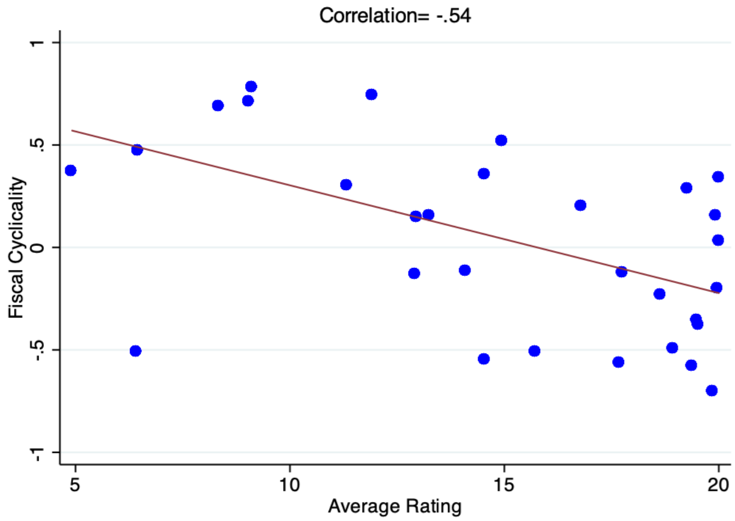
ments (and other). On average total expenditure constitutes 40% of GDP, with a standard deviation of 11p.p. We focus on the first two categories, which jointly account for on average 50% of total fiscal expenditures. The two categories differ markedly in their character, in that the first one is a public good and the second one is an insurance good. Use of goods and services (later simply referred to as *government consumption*) are defined as "value of goods and services used for the production of market and non-market goods and services" and are a public good: non-excludable and non-rivalrous, and whose consumption is neutral or complementary to private income and consumption. Social transfers (later simply referred to as *transfers*) are transfers receivable by households related to social risks such as sickness, unemployment, retirement, housing, and education. They work as an insurance good, a substitute to the private income.

We use sovereign debt rating from S&P, Fitch and Moody's collected in House, Joy and Sobrinho (2017) and extend its time coverage over to 2015. We encode the original alphanumerical ratings with integers, denoting the highest rating (AAA or Aaa) with 20 and lowest ratings (C and RD) with 0. The data on sovereign debt ratings is annualized: within each year for each rating agency we calculate the time-weighted average rating and then average this across the three agencies. The average sovereign rating reflects the riskiness of the country's sovereign debt. This riskiness drives access to foreign credit, which is an important source of financing especially for emerging economies (Paczos and Shakhnov, 2019, Reinhart and Rogoff, 2011b). As a result, in emerging economies access to foreign credit is procyclical and countercyclical spreads are an important driver of the business cycle (Neumeyer and Perri, 2005). Sovereign ratings for each country are stable over the sample period: the standard deviation of the average rating is low. This validates the use of mean rating as a meaningful indicator of the mean riskiness of the economy over the sample period.[5]

Cyclical components of GDP and fiscal expenditure series are measured as deviations from the linear-quadratic trend. We calculate correlations of the GDP cyclical component with the fiscal expenditure cyclical components. In the following graphs we present the evidence on the relationship between the cyclicality of fiscal expenditures and the sovereign risk.

[5]Table 6 in the Appendix shows how we encode the ratings. Table 7 in the Appendix presents time averages of the GDP growth, fiscal expenditure components, rating and standard deviation of rating for each country in the dataset.

Figure 1: Cyclicality of fiscal expenditure and country rating

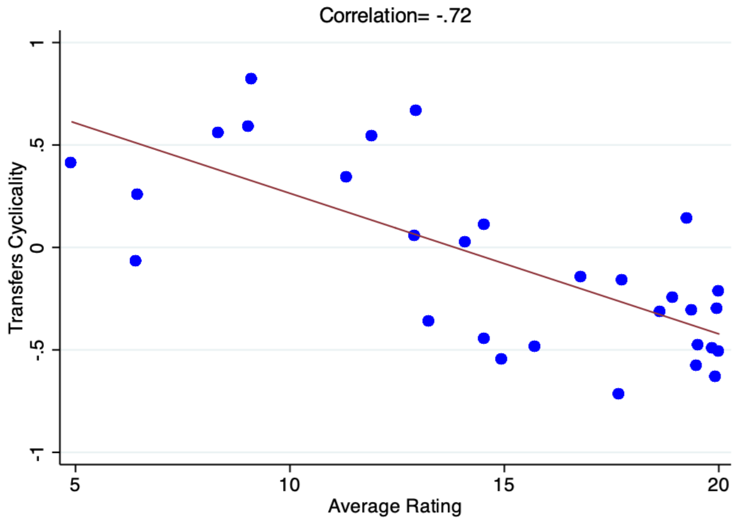


Source: Own calculations based on Michaud and Rothert (2018) and S&P, Fitch and Moody's sovereign debt ratings.

Figure 1 plots the correlation of total fiscal expenditure with the GDP on the vertical axis against the average sovereign debt rating on a horizontal axis. The higher is the correlation, the more procyclical fiscal expenditures are. The higher is the average rating, the safer is the debt issued by a government. Countries with better credit rating, thus lower and less volatile average interest rates, have more countercyclical fiscal expenditures. The correlation between fiscal expenditures cyclicality and average rating is significant and estimated at -0.54.

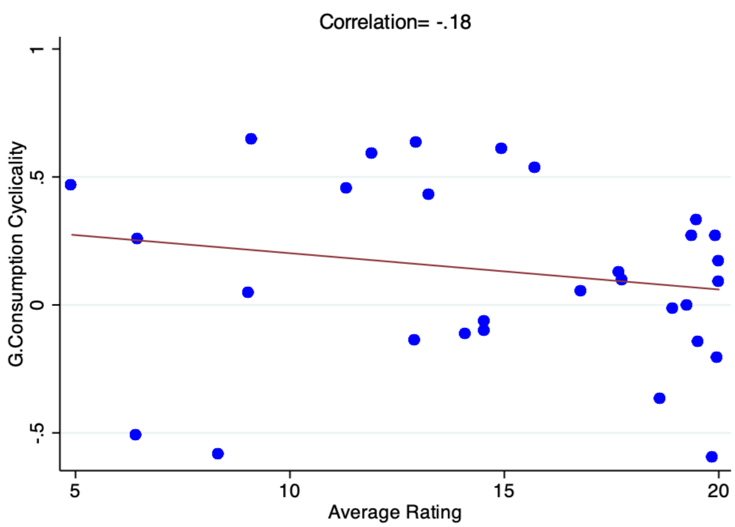
Figure 2 plots the cyclicality of transfers against the average sovereign debt rating. Transfers are highly procyclical in economies with low rating and highly countercyclical in economies with high rating. The correlation of transfers cyclical component with GDP cyclical component is 0.6 for an economy with an average rating of 5 and -0.5 for an economy with an average rating of 20. The correlation between transfers cyclicality and the average rating is significant and negative (-0.72). In Figure 3 we plot the cyclicality of government consumption against the average sovereign debt rating. Government consumption is on

Figure 2: Cyclicality of transfers and country rating



Source: Own calculations based on Michaud and Rothert (2018) and S&P, Fitch and Moody's sovereign debt ratings.

Figure 3: Cyclicality of government consumption and country rating



Source: Own calculations based on Michaud and Rothert (2018) and S&P, Fitch and Moody's sovereign debt ratings.

average close to acyclical and, unlike total fiscal expenditure, there is no clear relationship between sovereign risk and government consumption. The correlation between the two variables is only -0.18.[6] We conclude that transfers are the driving force behind the observed cyclicality of total fiscal expenditure and that this cyclicality is strongly correlated with the riskiness of the government debt.[7]

The transfers component of government expenditure, an important component of both advanced and developing countries today, affects the cyclicality of government expenditure more significantly across countries than government consumption and can explain a large share of differences between advanced and developing countries. Transfers predominantly serve as an insurance device for private households (such as sickness or unemployment benefits) or are targeted towards a certain group in the population. The degree of financial friction is much higher in developing countries: external debt remains an important source of finance in many emerging economies and the conditions under which countries can borrow are countercyclical. Default incentives on external debt are highly countercyclical, while default incentives on domestic debt much less so (Paczos and Shakhnov, 2019). The presence of financial frictions can thus potentially contribute to explain fiscal procyclicality. In the next section we present and quantify such a mechanism against the data.

4 Model

We consider a production economy with heterogeneous agents, a benevolent government and competitive international financial markets with risk neutral investors. The government provides a public good (g^P) and social transfers (g^T) uniformly to all households. Expenditures are financed by taxing households and by borrowing and saving internationally with risk neutral investors. Taxation is costly because the government cannot collect lump sum taxes. Instead, it can only levy a proportional consumption tax on households. We assume that international financial markets are incomplete: the government has access to a non state contingent bond only, and it has no commitment to repay the debt.

[6]The second largest expenditure category, on average, is the compensation of public employees. Theoretically there is a more clear cut difference between the role of transfers and government consumption compared to compensation of employees. Empirically, the correlation of compensation of employees cyclicality with average rating is -0.3, higher than the correlation of government consumption cyclicality, yet much smaller than the correlation of transfers cyclicality.

[7]This finding is robust to the exclusion of outliers and the length of the period for which the cyclicality is calculated.

After the setup of the model, we demonstrate the effect of financial market incompleteness with two extreme scenarios: complete international financial markets, and autarky, before reporting results from simulating the numerical solution of incomplete markets model with default risk.

There are a continuum of households in the domestic economy. The population size is constant and normalized to 1. Household differ in to their labor productivity e^i, which takes on different values in the interval $e^i \in (0, 1]$. A constant fraction σ^i has high labor productivity e^i and the individual productivities are private information. Households supply labor elastically, and we denote hours worked of household with productivity e^i by h^i_t. There is aggregate productivity risk in the economy, A_t, such that total pre-tax income is $A_t e^i h^i_t$.

Households maximize expected lifetime utility, a discounted stream of utilities from private consumption, leisure, and public good consumption:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t [\kappa u(c^i_t, h^i_t) + (1 - \kappa) v(g^P_t)], \tag{1}$$

subject to the budget constraint

$$(1 + \tau_t) c^i_t = A_t e^i h^i_t + g^T_t, \qquad \forall i. \tag{2}$$

The public good g^P_t is additively separable in the utility function. The weights on private and public consumption are κ and $(1-\kappa)$, respectively. With this formulation, the marginal utility of private consumption is independent of public consumption. τ_t is a tax rate on consumption expenditures, g^T_t is a lump sum transfer from the government. It is not restricted to be positive, but as long as productivity differences are large enough, transfers will optimally be positive.

Agents have no access to financial markets. Thus, two interpretations of productivity heterogeneity are possible in this framework: On the one hand, agents can be assumed to be ex ante identical; due to the absence of financial market access their productivity level will be the only relevant state variable. On the other hand, the economy is one of persistent inequality, both in income and in the distribution of skills.

Denote by c^{i*}, h^{i*} the policies that solve the households' problem. Since the problem is static, we suppress time subscripts for the ease of notation. The first order optimality conditions satisfy equations (2) and:

$$-\frac{u_h(c^{i*},h^{i*})}{u_c(c^{i*},h^{i*})}=\frac{Ae^i}{(1+\tau)}, \qquad \forall\, i. \tag{3}$$

Total output is defined as $Y \equiv A\sum_i \sigma^i e^i h^{i*}$. The government can borrow and save in international bond markets with risk neutral creditors. Risk neutral creditors discount future consumption at a constant rate $\delta = (1+r)^{-1}$, where r is a world interest rate. The government likes to front load consumption because the world interest rate is lower than its subjective discount rate: $\beta < (1+r)^{-1}$. This implies there is a persistent difference between interest rates in the country and the rest of the world.

The government cannot commit to repay its international obligations. Instead, it can decide in each period to default on all currently outstanding debt. It then temporarily loses access to financial markets. If it repays, it retains market access.

Define that aggregate state of the economy as $S = (A, b)$, where b is a level of public debt. Debt affects households' decisions via its effect on taxes and both fiscal expenditures. Denote by $V^d(S)$ the value function of the government if it defaults and by $V^{nd}(S)$ the value function if the government repays. The default decision is made in the beginning of each period, after the realization of the productivity state. The value function of the government reads:

$$V^0(S) = \max_{d\in\{0,1\}}(dV^d(S) + (1-d)V^{nd}(S)). \tag{4}$$

International creditors have perfect information about the borrowing country's fundamentals and anticipate default decisions. Denote by $\pi^{def}(b'(S), A)$ the probability that the country defaults when borrowing b' today. $\pi^{def}(b'(S), A)$ is the sum of conditional probabilities of the future state given the current state A, for which default occurs. There is free entry in the credit market. Thus, creditors set the bond price in order to satisfy the zero profit condition

$$-q(b'(S),A)b'(S) + \frac{(1-\pi^{def}(b'(S),A))}{1+r}b'(S) = 0. \tag{5}$$

If $\pi^{def}(b'(S), A)$ is positive for some A, the bond price falls. If the government wants to roll over its debt, it needs to use additional resources to finance the repayment since creditors are only willing to extend new debt at a discount. Hence default risk leads to endogenous borrowing constraints.

The government maximizes total welfare. There is a fraction σ_i of productivity type i in the population. The government attaches welfare weight α_i to this type. In the benchmark case when $\sigma_i = \alpha_i, \quad \forall i$, the government is utilitarian. The government chooses optimal policies such that the households' first order conditions are satisfied, and its own budget constraint holds.

When the government has market access, it chooses taxes, two fiscal expenditures and bond issuance $\{\tau(S), g^T(S), g^P(S), b'(S)\}$ as functions of the aggregate state $S = (A, b)$. It solves the following maximization problem:

$$V^{nd}(S) = \max_{\{\tau, g^T, g^P, b'\}} \left\{ \kappa \sum_i \alpha^i u(c^{*i}, h^{*i}) + (1-\kappa)\nu(g^P) + \beta \mathbb{E} V^0(S'|S) \right\} \tag{6}$$

subject to households' budget constraint (2), their first order condition (3), bond discount price (5) and government budget constraint:

$$g^P + g^T + qb' = \tau C^* + b \tag{7}$$

where aggregate consumption is defined as $C^* = \sum^i \sigma^i c^{*i}$. We adopt a notation in which public debt is represented by a negative b. The price of consumption is normalized to 1.

After a default the government loses market access. With a constant probability μ it regains access to markets in subsequent periods. It re-enters markets with zero assets and no negative credit history. Furthermore, following literature, we assume that the country incurs an asymmetric proportional productivity loss θ during the default spell:[8]

$$A^d = g(A) = \begin{cases} A & \text{if } A < \theta \mathbb{E}[A] \\ \theta \mathbb{E}[A] & A \geq \theta \mathbb{E}[A]. \end{cases} \tag{8}$$

Part of the total output loss is endogenous due to elastic labor supply. When the

[8] Mendoza and Yue (2012) and Kaas, Mellert and Scholl (2020) provide a microfoundation of how asymmetric output losses can arise in equilibrium, when firms use imported inputs in production.

government defaults, it chooses g_d^P, g_d^T, τ_d to maximize:

$$V^d(S) = \max_{\{\tau_d, g_d^T, g_d^P\}} \left\{ \kappa \sum_i \alpha^i u(c^{*i}, h^{*i}) + (1-\kappa)\nu(g_d^P) + \beta \mathbb{E}\left[\mu V^0(S') + (1-\mu) V^d(S') | S \right] \right\} \tag{9}$$

subject to (2), (3) and its budget constraint in default:

$$g_d^P + g_d^T = \tau_d C^*. \tag{10}$$

4.1 Equilibrium

Definition: Equilibrium

A dynamic recursive equilibrium in this economy is a set of households decisions $\{c^i(S), h^i(S), c_d^i(S), h_d^i(S)\}$ government default policy $d(S)$, government policies $\{g^T(S), g^P(S), b'(S), \tau(S), g_d^T(S), g_d^P(S), \tau_d(S)\}$, and a bond price policy function $q(S)$ such that:

(a) Given bond prices and government policies, the household decisions solve the households' maximization problem (1).

(b) Given bond prices and household decisions, the government policies solve the government's maximization problem (4).

(c) Lenders' beliefs are consistent with default probabilities and the resulting bond prices satisfy the zero profit condition (5).

In what follows, we assume that household preferences are of the GHH form:

$$u(c,h) = \frac{\left(c - \chi \frac{h^{1+\phi}}{1+\phi}\right)^{1-\gamma}}{1-\gamma}, \qquad \nu(g^P) = \frac{g^{P\,1-\gamma}}{1-\gamma}. \tag{11}$$

With GHH preferences, there is no wealth effect on labor supply: the marginal rate of substitution between consumption and hours worked is independent of consumption. This specification simplifies the analysis by abstracting from direct supply side effects of transfers. Furthermore, these preferences help to match the stylized facts of small open economies quite well: hours worked are positively correlated with GDP. The elasticity of hours worked with respect to the wage rate is constant and equal to $1/\phi$. For simplicity, we suppress the functional dependence of the optimal policies on the state variables in the following paragraphs. Optimal hours worked can be solved for using the marginal rate of substitution directly:

$$h^{*i} = \left(\frac{1}{\chi} \frac{Ae^i}{(1+\tau)} \right)^{\frac{1}{\phi}}, \qquad \forall i. \tag{12}$$

And, using households' budget constraint, consumption reads:

$$c^{*i} = \frac{1}{\chi}^{\frac{1}{\phi}} \left(\frac{Ae^i}{(1+\tau)} \right)^{\frac{1}{\phi}+1} + \frac{g^T}{1+\tau}, \qquad \forall i. \tag{13}$$

Furthermore, note that

$$\frac{\partial h^i}{\partial \tau} = -\frac{1}{\phi(1+\tau)} h^i \tag{14}$$

and define the elasticity of labor supply in response to the tax rate $\xi_{h,\tau}$ as

$$\xi_{h^i,\tau} = \frac{\partial h^i}{\partial \tau} \frac{\tau}{h^i} = -\frac{\tau}{\phi(1+\tau)}. \tag{15}$$

The first aggregate condition (when the government has market access) is the Euler equation which determines aggregate public good consumption dynamics:

$$\nu'(g^P) \left[q + b' \frac{\partial q}{\partial b'} \right] = \beta \mathbb{E}_{A': d(A',b')=0} \nu'(g^{P\prime}) \tag{16}$$

When choosing bond policy today, today's marginal utility of government consumption is equalized only with marginal discounted expectation of future marginal utility in the states when the government repays. This is because there is no intertemporal decision to be made when defaulting. Secondly, the pricing term on the left-hand side shows the effect of default risk as a borrowing constraint on consumption: $b' \frac{\partial q}{\partial b'}$ is zero whenever the country is not going to default on its debt in any state in the future. However, when $\pi^{def} > 0$ (for some A given b'), then the derivative is positive. Since $b' < 0$, the whole term on the LHS decreases when π^{def} increases. Hence, ceteris paribus, when the bond price falls due to a risk of default the government needs to cut down public consumption.

Equation (17) is the optimal choice of the tax rate. The aggregate distortion on output summarized by the elasticity of labor supply with respect to the tax rate $\xi_{h^i,\tau}$, must equal the deviation from the socially optimal allocation of risk sharing, the *risk sharing wedge*, weighted by individual consumption and output, respectively. In other words, the tax rate is set such that the difference in marginal utilities in consumption units, corresponds to the marginal utility cost of the output loss due to the tax distortion, converted to output units. The elasticity is constant *for a given tax rate*, and it is increasing in the tax rate (equation (15)). Thus, the distortion due to the taxation of labor supply and the welfare loss are convex in τ.

$$\sum_i \alpha^i \left[\kappa u_c^i(c^i, h^i) - (1-\kappa) v'(g^P)\right] c^i = (1-\kappa) v'(g^P) A \sum_i \sigma^i e^i h^i \xi_{h^i,\tau}. \tag{17}$$

Lastly, (18) determines the relationship between private and public good consumption when transfers are chosen optimally. The government chooses the transfer such that the weighted sum of marginal utilities from consumption equals the marginal utility from spending on the public good. In other words, the risk sharing wedge is zero on average:

$$\kappa \sum_i \alpha^i u_c^i(c^i, h^i) = (1-\kappa) v'(g^P). \tag{18}$$

The extent to which the government can use international financial markets also determines residual idiosyncratic income risk. If financial markets are a good instrument to smooth consumption, borrowing and saving will be a complementary instrument to the tax rate. Public good spending is not an instrument to help smooth private consumption, as its demand by private households is complementary to their own consumption.

The assumption of elastic labor supply is important for two reasons: first, without elastic labor supply, taxation is not costly and the government can adjust the tax rate to finance spending, independently of the size of the tax rate, and the state of the economy. There is thus no well defined trade-off between taxation and spending. Second, and as a consequence, if the tax rate is not distortionary, it is optimal for the (utilitarian) government to tax away all income and equalize consumption across agents. Unless the country can fully insure against domestic productivity shocks, consumption will co-move with GDP. Even if full insurance is possible, transfers (and consumption) could at most be acyclical. Because all income derives from transfers, transfers will be procyclical. This case is both counter-intuitive because the trade-off between taxing and spending is missing and counterfactual, because this correlation is not observed in the data.

There is no analytical solution to this problem. Therefore, in the remainder of the paper we use a calibrated version of the model to demonstrate how limited market access affects the cyclical behavior of transfers policy.

4.2 Redistribution with an affine tax system

We use an affine tax system in this paper. Other recent work formulating optimal tax and transfer policy using this functional form are Bhandari, Evans, Golosov and Sargent (2017) in the context of debt policy with inequality and Heathcode and Tsujiyama (2020) in a comparison of approaches to redistribution. The system is redistributive through the combination of a proportional tax and lump sum transfer. The transfer shifts down total tax payments by the same amount for all households, so lower income households, who face a lower tax bill, may end up receiving a net subsidy, depending on the level of transfers. The level of transfers (and taxes) in turn depends on the degree of inequality: for very low levels of inequality, a negative transfer (and thus lump sum tax) would be optimal. The higher is inequality, the more the government wishes to utilise transfers at the expense of higher taxes, as equation, cf. 17. It thus uses transfers and taxes as incompletely targeted but complementary instruments. In the model, the level of taxes and transfers are determined endogenously. We find that when we calibrate the model to match low levels of inequality (such as in Canada), transfers are optimally positive and redistribution actively happens.

4.3 Full Insurance and Autarky

This section derives analytical results for the two polar cases of full insurance and financial autarky. For simplicity, there are two types of households, high productivity e^h and low productivity e^l households, with population shares σ, $(1-\sigma)$, respectively, and we assume that the earnings ratio is such that g^T is positive.

Under full insurance, the government acts as in full commitment and enjoys access to a full set of state contingent assets that it can trade with competitive risk neutral investors. Full insurance eliminates aggregate risk in this economy, and the marginal utility cost of resources is constant. The price of an Arrow security for the future productivity state A^r when the current state is A^u is $\beta\pi(r|u)$, with $\pi(\cdot)$ is the conditional switching probability.

From the Euler equation,

$$\nu'(g^P(r)) = \nu'(g^P(u)), \qquad \forall\, r \neq u.$$

The risk sharing condition implies for households that

$$\sigma \Delta u_c(c^h, h^h) = -(1-\sigma)\Delta u_c(c^l, h^l). \tag{19}$$

The optimal policy either equalizes marginal utilities of consumption across states, or sets taxes and transfers such that marginal utilities move in opposite directions. Consider a policy that implies a procyclical $u_c(c^l, h^l)$, and a countercyclical $u_c(c^h, h^h)$. Since agents are risk averse, this implies that the change in consumption for the low productivity agent needs to be strictly lower than for the high productivity agent, which points towards higher transfers during periods of low aggregate productivity. On the other hand, because $e_h > e_l$, the income change will be larger for high productivity agents, implying a larger change in consumption keeping transfers constant. Finally, higher transfers mean that taxes cannot be decreased by as much because the government cannot finance both public good spending and transfers via external finance. Hence, transfers will be countercyclical only if the insurance motive for the government is strong enough and the additional welfare cost from taxes are moderate, but higher than zero.

The last requirement is derived from a necessary condition for countercyclical transfer policy: the government chooses not to undo productivity shocks completely using taxes. Intuitively, when taxes are distortionary, this policy is not a solution to the Ramsey problem independently of the assumption on market access.

$$\xi_{\tau,A}\frac{\tau}{1+\tau} = \frac{\partial \tau}{\partial A}\frac{A}{\tau}\frac{\tau}{1+\tau} < 1 \tag{20}$$

Under complete markets, the government provides consumption insurance to private households, but most effectively to low income agents. Their marginal utility of consumption is procyclical, whereas that of high income households is countercyclical. This policy is associated with countercyclical $\tilde{g}^T$, as summarized by the following proposition. Furthermore, consumption dispersion is procyclical.

Proposition Suppose preferences are such that (20) holds. Then:

$$\frac{\partial MUC(h)}{\partial A} > 0, \frac{\partial MUC(l)}{\partial A} < 0 \qquad \Leftrightarrow \frac{\partial \tilde{g}^T}{\partial A} < 0. \tag{21}$$

Proof: See appendix 7.4.

In autarky, there is no possibility to smooth income and the marginal utility cost of resources and public consumption move with aggregate productivity. With GHH preferences and constant *relative inequality*, it is optimal for the government to keep the tax rate constant with productivity.[9] The proceeds are used to finance public good and transfers, which are procyclical due to procyclical revenues and the public good spending pattern. While relative inequality is constant, absolute inequality (the absolute earnings difference) is procyclical. Thus, to maximize social welfare, social transfers are procyclical, reflecting the procyclial policy motive. The optimal policy will result in constant relative consumption over the business cycle.

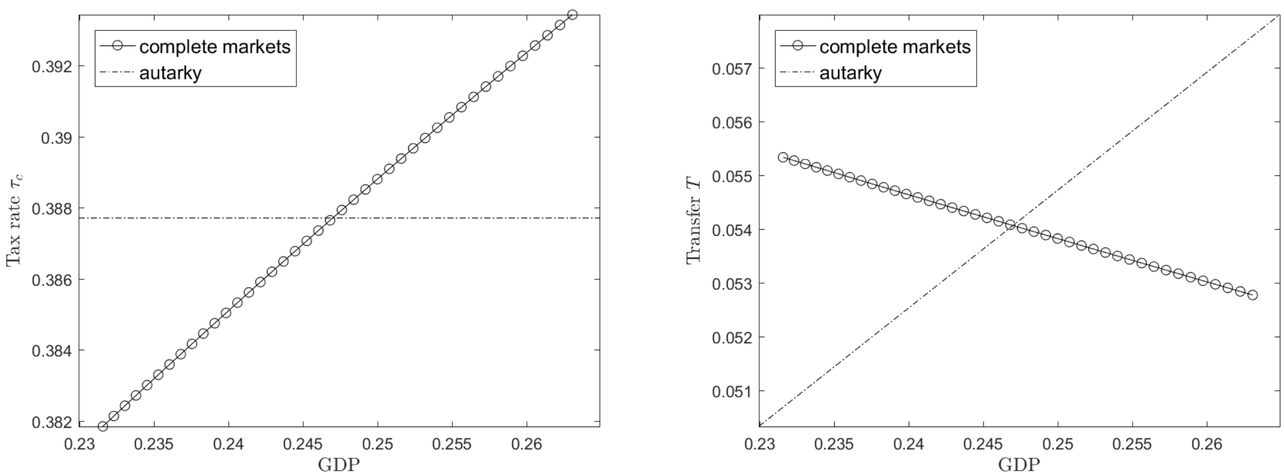
Figure 4 shows the optimal tax policy (left panel) and the optimal transfer policy (right panel) as a function of GDP for autarky and complete markets. Optimal transfer policy is depicted in the right panel. While the tax rate remains constant under autarky it co-moves with GDP. Transfers are countercyclical under complete markets because the government insures households against aggregate shocks.

5 Results

The aim of the calibrated model is to illustrate the dynamics of a typical emerging economy, rather than to replicate the actual data of any particular country. Yet, for the exercise to be meaningful, we aim for overall consistency. We follow what is regarded as a standard calibration in the literature as closely as possible and in the dimensions that require rigorous quantitative treatment the parameters are calibrated using data for Brazil. Brazil is a typical emerging market economy with procyclical fiscal policy, history of defaults and large inequalities.

[9]See appendix 7.5

Figure 4: Optimal taxes (left) and transfers (right) as a function of GDP



5.1 Calibration and Functional Forms

The period in the model is a quarter. We use standard values for four parameters, as shown in Table 1. We set risk aversion γ to 2 and the risk-free rate r at 1% quarterly. Following Michaud and Rothert (2018), we set the Frisch elasticity of labour supply ϕ to 0.6. The government is utilitarian: $\alpha^i = \frac{1}{I} \quad \forall i$. We use five types of households and thus $\alpha_i = 0.2 \quad \forall i$.

Table 1: Set parameter values

	Parameter	Value	Source
γ	Risk aversion	2	Standard in the literature
r	Risk-free rate	1.0%	Standard in the literature
ϕ	Inverse of Frisch elasticity	0.6	Michaud and Rothert (2018)
α_i	Welfare weights	Equal	Utilitarian government

Table 2 provides a summary of the calibration. We calibrate the disutility of labor χ at 0.81, such that households spend 1/3 of their time working. The weight of private consumption in households' utility κ is estimated at 0.845 to match a transfers-to-public-good ratio (g^T/g^P). We calculate this ratio from the Michaud and Rothert (2018) database. The overall average in the sample of 13 developing countries is 2.08 and the median is 1.82.

Table 2: Calibration

	Parameter	Value	Target	Value
χ	Labor disutility	0.81	Time worked	0.33
κ	Private utility	0.845	Transfers-to-public good	1.85
ρ_A	TFP persistence	0.921	Output persistence &	0.885
σ_ϵ	TFP volatility	0.00415	volatility	2.65%
μ	Re-entry probability	0.2	Market exclusion	5
β	Discount factor	0.945	Debt service-to-GDP &	2.10%
θ	Ouput penalty	0.9892	default frequency	2.84%
e^i	Productivities	{0.27, 0.44, 0.49, 0.56, 1}	Pre-tax income ratios	{0.03, 0.11, 0.15, 0.21, 1}

We target the value of 1.85, which is also the average ratio for Brazil before 2005.[10]

Total factor productivity is stochastic, and it follows a log-normal AR(1) process:

$$\log(A_t) = \rho \log(A_{t-1}) + \epsilon_t, \quad \epsilon_t \sim N(0, \sigma_\epsilon). \tag{22}$$

The quarterly persistence ρ and the standard deviation ϵ of the TFP process are such that the simulated output series have the same persistence and standard deviation as the cyclical component of output in Brazil. We extract the cyclical component by removing the linear-quadratic trend in the GDP series in logs sourced from Michaud and Rothert (2018). The annual output series have a persistence of 0.61 and a standard deviation of 4.5%, which corresponds to quarterly values of 0.885 and 2.65%.[11] The estimated values are $\rho = 0.921$ and $\epsilon = 0.00415$.

We calibrate individual productivities e^i to match income quintiles and pre-tax-and-transfers Gini coefficients using the data on pre-tax national income distribution in Brazil from the World Inequality Database.[12] Income quintiles are measured as income per capita, in local currency with PPP in constant 2018 prices. Pre-tax incomes relative to the top quintile in 2015 in Brazil are, starting with the lowest quintile, $\{0.03, 0.11, 0.15, 0.21, 1\}$. In this model, this implies a vector of $e^i = \{0.2685, 0.4370, 0.4909, 0.557, 1\}$. The pre-tax-and-transfers Gini coefficient in the model is 0.54, very close to its empirical equivalent of 0.53 (SEDLAC, 2018).[13]

[10] After this year this series is characterized by discontinuous jumps.

[11] Aggregating an AR(1) process from quarterly to yearly series one gets $\rho^y_{quarter} = {\rho^y_{year}}^{1/4}$ and $\epsilon^y_{quarter} = \epsilon^y_{year} / \sqrt{1 + {\rho^y_{quarter}}^2 + {\rho^y_{quarter}}^4 + {\rho^y_{quarter}}^6}$.

[12] WID.world, accessed online May 2021.

[13] We have also solved the model with only two types of households and with ten types of households.

We calibrate the remaining three parameters, the subjective discount factor β, the output loss θ and market exclusion upon default μ in the following way. First, all three parameters jointly determine debt policy of the government. It is well recognized that sovereign default models with one-period debt are not well suited to match debt-to-GDP ratios. Instead, we follow the literature and target debt-service-to-GDP ratio. For this, we use the average of the "public and publicly guaranteed debt service (% of GNI)" series for the years 1970-2018 in Brazil from the World Development Indicators (World Bank, 2021) of 2.1%. While β and θ change the mean debt service in the model, μ critically affects how much debt the government takes in the bad times: the lower is the probability of re-entry the less the government is willing to take on debt when output is low. Second, the probability of market re-entry, μ also governs the expected time of exclusion following a default, which is equal to $1/\mu$. Empirically observed exclusion periods differ widely from 4.7 to 13.7 years (Schmitt-Grohé and Uribe, 2017), while quantitative sovereign default literature usually uses values of μ between 0.1 (Cuadra et al., 2010) and 0.282 (Arellano, 2008). We take a conservative approach and set $\mu = 0.2$ implying an expected exclusion time of 5 quarters and a reasonable debt policy when output is low. Third, all three parameters jointly determine the frequency of default. For this we note that Brazil had two defaults on foreign debt in the postwar period in 1961 and 1983 (Reinhart and Rogoff, 2011a), which gives us the target of 2.8% yearly default probability when calculated over the years 1945-2016. Having set $\mu = 0.2$ the remaining parameters are estimated at $\theta = 0.9892$ and $\beta = 0.945$ to match debt service and default frequency. Later, we study the sensitivity of the results subject to changes in these three critical parameters.[14]

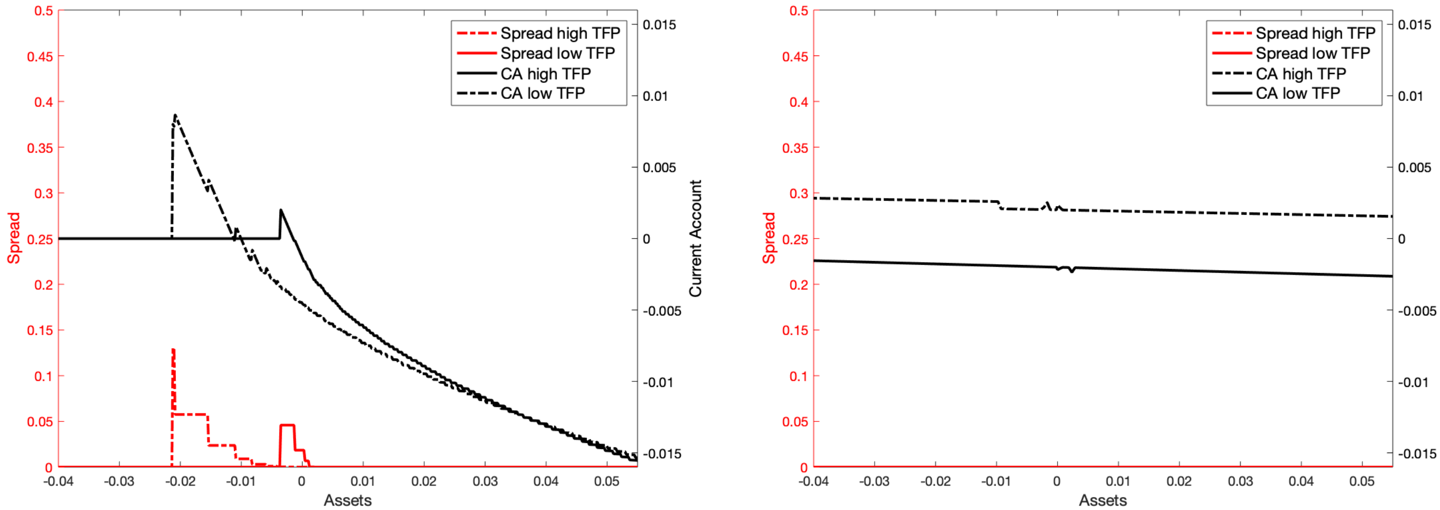
5.2 Policy functions

In this section we present the equilibrium policy functions from the model. We discuss the results by comparing the benchmark ("risky") economy calibrated as in section 5.1 against a "safe" economy. In the safe economy the government never enters the zone of positive

While the model with two types does not provide a satisfactory approximation of inequality, the results of the model with ten types are quantitatively indistinguishable from the model with five types.

[14]The incomplete markets model is solved by value function iterations using the two-loop algorithm suggested by Hatchondo, Martinez and Sapriza (2010). The productivity is discretized with 41 states, the first loop iterates on the current account grid discretized with 2001 points and the second loop iterates on the asset (debt) grid discretized with 1001 points, which are comfortably twice as high as in Cuadra et al. (2010).

Figure 5: Current account as a function of asset holdings in the risky (left) and safe economy (right).



risk premia. This is achieved by calibrating the default penalty θ very low and the discount factor β very high.[15]

Default risk has several effects in this model. First, it endogenously limits the debt that can be accumulated by the country. Second, it potentially limits the government's ability to smooth income when the bond price falls and an endogenous borrowing constraint becomes binding. If the government cannot borrow when it incurs a series of bad shocks, transfers will be set in a procyclical fashion. When borrowing constraints are slack, the correlation of transfers and GDP is lower than when they are tight. Thus, this model shows that borrowing constraints lead to more procyclical transfer policies and strongly procyclical total government expenditures. The policy functions for transfers and current account illustrate this mechanism. The policies for borrowing is standard in the literature, and the mechanism for taxes follows that of (Cuadra et al., 2010), so we describe them only briefly below.

Figure 5 plots the current account policy in the risky economy in the left panel and safe

[15]The default penalty is the inverse of the value of commitment: with a low value the government is effectively discouraged from ever choosing to default. Since in the benchmark calibration the government is less patient than the market, this alone would result in the government always choosing the maximum permissible level of debt on the grid. We increase the patience of the government by setting $\beta = 1/(1+r) - \epsilon$, where $\epsilon = 10^{-6}$. We set $\theta = 0.01$.

economy in the right panel. As for all figures that follow, the policies are plotted as functions of the current asset position. Black lines plot the optimal current account policies for high (solid) and low (dashed) aggregate total factor productivity (TFP). The respective scale is on the right vertical axis. High and low productivities are chosen as +/- one standard deviation from the unconditional mean. Additionally, we plot the equilibrium spread in red: for high (dashed) and low (solid) aggregate productivity as a function of the current asset position.[16] The government in the safe economy (right panel) conducts a countercyclical current account policy: it borrows from foreign investors (runs negative current account) when TFP is low and repays when TFP is high. Debt is always safe and the spread is always zero. A similar policy can be observed in the risky economy when it enjoys a substantial stock of assets (right end of the graph). In contrast, as more debt is accumulated in the risky economy, spreads increase and it does so more when TFP is low for a given level of debt, because incentives to default fall with TFP, leading to a procyclical current account.

What is the measured cyclicality in the model is ultimately a quantitative question and depends on the two driving forces of exogenous TFP shocks (switching between the lines on the graph) and endogenous debt policy (movement along the lines).[17] In other words, how often a country visits particular areas on the graph. For example, on the left end of the graph the cyclicality switches again and the government runs a countercyclical policy - high assets with high TFP and zero assets with low TFP. This is however due to the fact that with low TFP a country is in default. In equilibrium this happens rarely - the calibrated frequency of default is 2.8%.

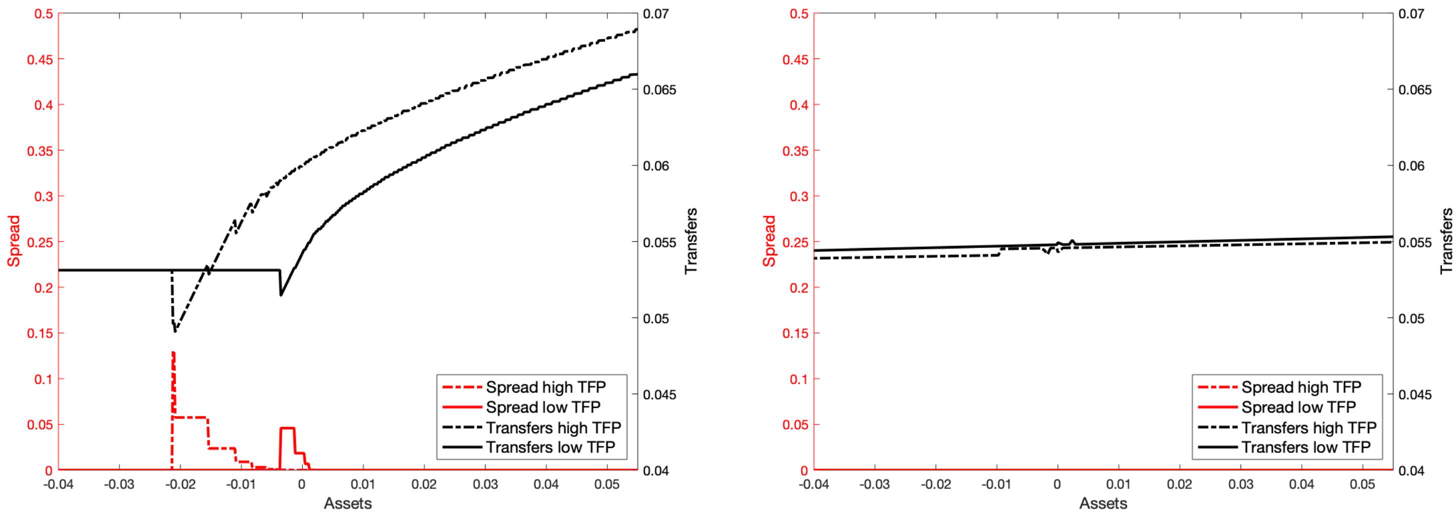
The endogenous borrowing constraint and its anticipation also affect the policy function for taxes. Taxes and current account are the two sources of the revenue for the government, so their equilibrium behaviour will impact on the spending policies: transfers and public good. In the safe economy tax policy is countercyclical (taxes go down when TFP goes down) and is countercyclical in the risky economy. This is as in Cuadra et al. (2010): when the government cannot borrow, it will shift towards financing expenditure by increasing the tax rate.[18]

[16]The stationary distribution of the safe economy has a considerably larger range than that of the risky economy. This is because the near absence of (endogenous) borrowing constraints makes responses to shocks much more persistent. For meaningful comparisons, we plot policy functions for two economies in the same domain.

[17]output from simulations is shown in section 5.4

[18]The graphs showing the behaviour of tax rate and public good are relegated to the Appendix 7.7.

Figure 6: Transfers as a function of asset holdings in the risky (left) and safe economy (right).



Optimal transfer policies are plotted in Figure 6. Similarly to the current account policies, the government in the safe economy conducts countercyclical fiscal policy: transfer are high when TFP is low and are low when TFP is high. This is driven by the consumption smoothing motive. The government intends to pay out more when aggregate productivity is low to support low income households and, crucially, is able to do so as debt is safe and spread is zero. It should be noted, that transfers are expressed in absolute terms (as are all other variables plotted in this section). The countercyclicality of transfer policy is significantly stronger when they are expressed in relative to GDP terms.

Transfers policies in the risky economy are very different. The government always runs a procyclical transfer policy. Here, the government solves the consumption smoothing-equality trade-off in the opposite direction. The intuition is the following. When TFP is high, absolute inequality (which enters the social welfare function) increases. This requires transfers to be increased. The consumption smoothing motive requires transfers to be decreased. This motive, however is weakened by the fact, that the government discounts the future strongly and anticipates borrowing constraints.

Furthermore, the gap between transfers during good and bad times is widening, the closer the economy gets to the risky zone - the positive spread acts like an active (endogenous) borrowing constraint. The policy function for transfers is steeper during low productivity realizations, and its slope increases in the immediate neighbourhood of the risky zone. This illustrates the gradual adjustment of transfer expenditure to anticipated and acute financing restrictions, which amplifies the procyclical motive of transfers, albeit through a different channel. When the country defaults, transfers jump as a result of the wealth effect in the default period. Recall that when the TFP is below the threshold value (8), default has no additional cost (other than temporary market exclusion), and that default is full. Thus, the marginal increase in resources is non-negligible.

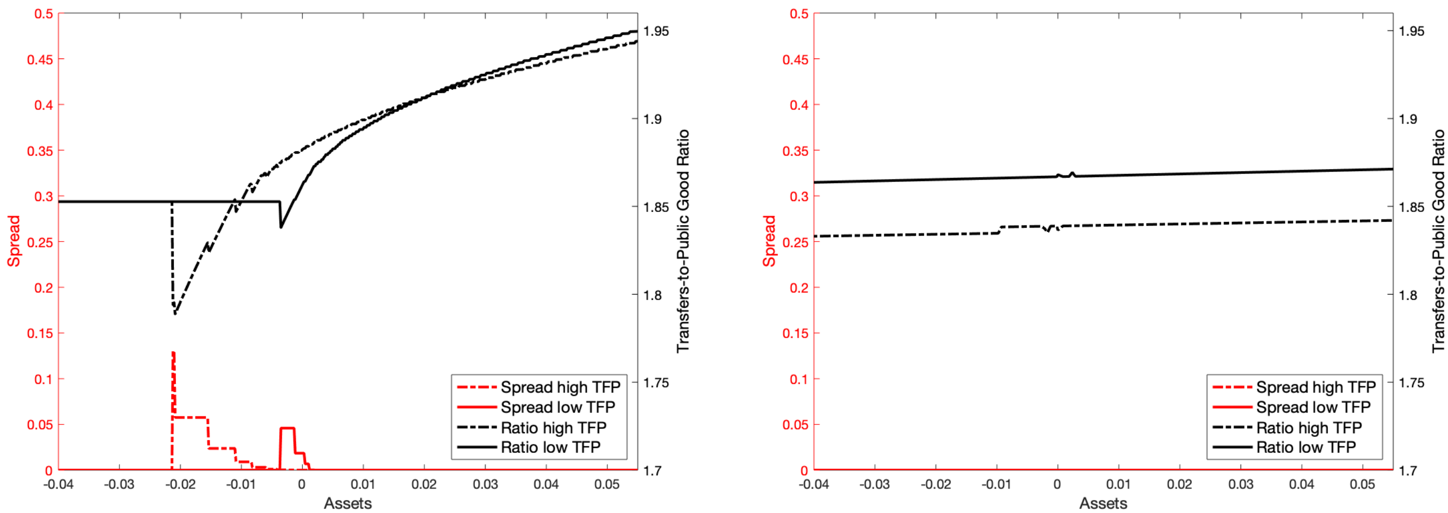
The other component of government expenditure, public good, is always procyclical when markets are incomplete, both in the risky as well as in the safe economy. This is because it is optimally set in accordance with aggregate income, as shown also by the zero-average risk sharing wedge in (18).

5.3 Fiscal Adjustment

Figure 7 shows the ratio of transfers to spending on public goods. In the safe economy the ratio goes up when TFP goes down. Intuitively, in a recession the government cuts public good spending relatively more than transfers. The ratio is countercyclical. During these episodes consumption inequality is procyclical as a result of active redistribution.

However, in the risky economy the ratio of transfers to public good spending is only countercyclical when the economy is not borrowing constrained (e.g. it has positive assets) and is procyclical when the economy is borrowing constrained. When spreads are positive, transfers fall rapidly and the ratio becomes procyclical. For high levels of assets, these dynamics follow directly from the fact that transfers are countercyclical and public good spending is procyclical, so the ratio is countercyclical. For intermediate asset levels and low debt, the current account is still procyclical, so the government will be able to use part of the newly issued debt to smooth households' consumption. As a corollary, in these situations, consumption is still less volatile than GDP. Thus, transfers fall by less than public good spending. The situation changes when borrowing becomes effectively costly. Now a larger share of revenue from taxation goes into financing of the debt. Furthermore, since the current account is procyclical, transfers are adjusted more than proportionately in response to productivity shocks. Transfers adjustment here is relatively less costly, because transfers are a perfect substitute to earnings, whereas taxes will lower output further and make

Figure 7: Transfers-to-public good ratio as a function of asset holdings in the risky (left) and safe (right) economy.

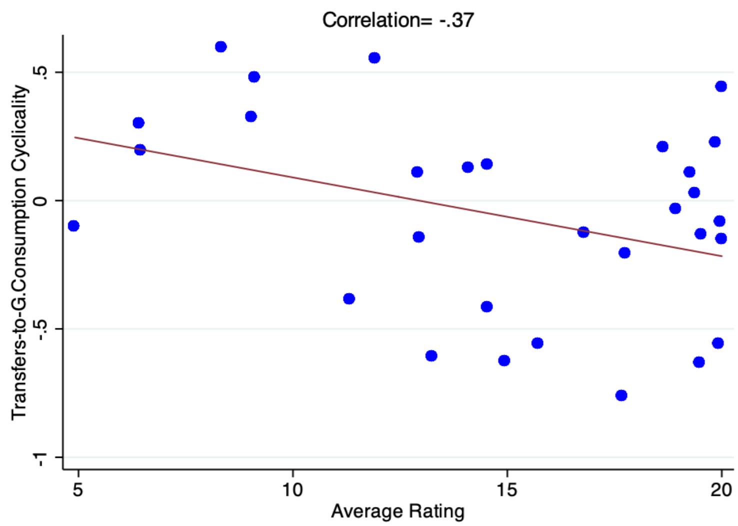


even less resources available for redistribution. As a result, in a recession the government cuts transfers relatively more than public good spending. Consumption then also exhibits 'excess sensitivity' to GDP - it falls by more than output, as consumption smoothing fails and consumption falls both because taxes increase, as well as because transfers fall.

Figure 7 offers an immediate testable implication of the model predictions. It shows that the cyclicality of the ratio of transfers to public good expenditure changes with the level of riskiness of the economy.

Figure 8 employs the data introduced in Section 3 and plots the observed empirical cyclicality of this ratio against the average rating of the country's public debt. Lower average rating is given to economies with riskier public debt. Empirically, there is a negative correlation between the cyclicality of the ratio and average rating of -0.37. Economies with higher average ratings experience more countercyclical transfers-to-public-good spending ratio. This empirically corroborates the model prediction.

Figure 8: Cyclicality of transfers-to-public-good spending ratio and country rating



5.4 Simulations

Table 3 presents the model fit. It lists moments computed from the simulated model against the moments obtained from the data for Brazil. The statistics are obtained by simulating the model 50 times for 1000 periods, discarding the first 50 periods. The model fits the data well along the calibrated dimensions. Importantly, in the model the government is benevolent and the transfer policy is set optimally: the government weights the losses in output from distortionary taxation against the gains of reduced inequality from transfers. As a result, the model overestimates the reliance of government on tax policies: in the data the government redistributes 6.5% of GDP in forms of taxes, while in the model this number is almost 22%. The model government is also able to reduce the inequality much more than observed empirically: the post-tax Gini coefficient in Brazil in 0.51 SEDLAC (2018), while in the model it is 0.45, compared to the pre-tax Gini coefficient of 0.53.

Finally, we discuss the model predictions along the untargeted dimensions. Table 4 compares the cyclical properties of the benchmark (risky) economy against the safe economy. In the risky economy, transfers are strongly procyclical. Absent sovereign risk, transfers turn countercyclical. The correlation of public good expenditures with GDP in the risky economy is close to one, whereas in the safe economy it is still positive but slightly lower.

Table 3: Model Fit

Statistic	Data	Model
Targeted Moments		
Pre-tax Gini	0.53	0.54
Output Persistence	0.885	0.883
Output Standard Deviation	2.65%	2.69%
Debt service-to-GDP	2.1%	2.1%
Default Frequency	2.8%	2.8%
Transfers-to-Public Good	1.8	1.8
Untargeted Moments		
Post-tax Gini	0.51	0.45
Transfers-to-GDP	6.5%	21.9%

Table 4: Cyclical Properties: Risky and Safe Economy

Statistic	Risky Economy	Safe Economy
corr(Transfers,GDP)	0.85	-0.12
corr(Public Good, GDP)	0.91	0.45
corr(Tax, GDP)	-0.23	0.83
corr(Current Account, GDP)	-0.24	0.83
corr(Spread, GDP)	-0.17	N/A
corr(Transfers/Public Good, GDP)	0.23	-0.84

Given that public good spending and transfers are highly correlated with output, overall government expenditure will be procyclical as well. In the risky economy, the interest rate is countercyclical as in the data, because bond prices tend to fall (spreads tend to rise) in recessions. This leads to a procyclical debt policy, visible as a negative correlation of current account and GDP. In recessions, due to high cost of borrowing, the risky economy repays the debt and runs a current account surplus. The risky economy borrows in booms, as the cost of debt is low. This is reversed in the safe economy. The safe economy is not faced with high borrowing costs and is able to save with the rest of the world in a boom and borrow in a recession. This demonstrates that borrowing constraints indeed drive procyclical transfer policies.

5.5 Robustness Analysis

In this section we use the model to study two counterfactual policy scenarios. In the first we relax the assumption that the government is utilitarian and calibrate the welfare weights

$\alpha_i \forall_{i=\{1,...,5\}}$ in the government problem (6)-(10) to match the empirical transfers-to-GDP ratio. In the second exercise we reduce inequality to a level that still admits positive transfers at the margin, and study how far it goes in altering the cyclical behaviour of the economy.

Non-utilitarian government. The benchmark model predicted a counterfactually high level of transfers. Optimally the government redistributes on average 22% of the GDP using transfers, while in the data it is only 6.5%. Transfers play two important roles in the model: they allow intertemporal consumption smoothing as well as they reduce intratemporal inequality. The first motive is countercyclical, while the second motive if procyclical. The fact that the model government overutilizes transfers (when compared to the data) might potentially overestimate the intratemporal, procyclical motive of the redistribution policy. In the first exercise we therefore relax the assumption that we government is utilitarian and weights all income groups equally. Instead, we assume that welfare weights α_i are derived from an exponential function with parameter λ and normalized to sum up to one:

$$\alpha_i = \frac{\lambda^i}{\sum_i \lambda^i}. \tag{23}$$

This specification reduces the transfers calibration problem to choosing one parameter: λ. With $\lambda = 1$ the government is utilitarian and weighs all income groups equally - as in the benchmark model. When $\lambda > 1$ the government puts more weight on high income groups, and when $\lambda < 1$ the government puts more weight on low income groups. We calibrate $\lambda = 2.5$ to match the transfers-to-GDP ratio of 6.5% on average.

The results of this exercise are summarized in the second column of Table 5. In the first column, the results from the benchmark model are repeated for convenience. Since the government is a pro-rich government, the redistribution motive is greatly reduced: the Gini coefficient after taxes and transfers is much higher than in the benchmark model: 0.51 compared to 0.45. Importantly, this matches the empirical Gini calculated on disposable income for Brazil (see Table 3). Since transfers are lower, so are taxes and the tax system is effectively less progressive than in the benchmark model. This slightly increases the probability of default, which is line with the results in Ferriere (2015): less progressivity encourages default since the cost of raising tax revenue from a larger mass of low-income households outweighs the cost of default. Yet, it should be noted that the effect on default probability is marginal. Most importantly, the change in the redistribution policy is quantitative and not qualitative: transfers are lower, but are still strongly procyclical, albeit less so than in the benchmark model. The correlation of transfers with output is 0.78 compared to 0.85 in the benchmark simulation. Foreign borrowing is more procyclical: the correlation of current account with output is -0.32 compared to -0.24. This is because the government is becoming less risk averse through the lower weight on low income households. At the same time, during periods when the borrowing constraint does not bind, transfers are less procyclical. This is because while consumption smoothing still fails, the government has a lower overall motive to redistribute income.

Low inequality. In the second exercise we calibrate inequality to a level where transfers are very close to zero, but always positive, so there is almost no redistribution. Notice that, as discussed in Section 4.2 this happens only at some positive levels of inequality. With small or no inequality the government would intend to use negative transfers instead, as they are non-distortionary.

We calibrate inequality such that transfers are only marginally positive on average. Pre-tax income ratios are set to $\{0.4, 0.5, 0.8, 0.9, 1\}$ in this scenario, which gives a the pre-tax Gini coefficient of 0.18. Since there is almost no redistribution, the post tax-and-transfer Gini is also equal to 0.18. The results of this exercise are reported in the third column of Table 5.

The results show that low inequality can go a long way in reducing the riskiness of the economy. The probability of default drops dramatically from 2.9% to only 0.15%. This helps to qualitatively change the tax and debt policy over the business cycle. Both foreign debt and tax policy become much less procylical: the measured correlation with output for both current account and tax rate drops by more than a half from around -0.24 to -0.11. Also, the government is borrowing less: the average foreign debt is only 0.4% of GDP compared to 2.1%. It should be noted however, that the GDP is much higher in this economy, as with this level of relative productivities, the whole economy is, on average, more productive than the benchmark economy. Even though transfer policy is close to absent, the tax rate is positive on average, as the tax proceeds are use to pay off foreign debt and fund the public good.

Table 5: Robustness Analysis

Moment	Benchmark	Non-utilitarian gov.	Low inequality
T/Y	21.9%	6.5%	0.0%
$Prob(Def)$	2.8%	2.9%	0.15%
B/Y	2.1%	2.1%	0.4%
$mean(spread)$	0.029	0.030	0.001
Pre-tax Gini	0.54	0.54	0.18
Post-tax Gini	0.45	0.51	0.18
$corr(CA, Y)$	-0.24	-0.32	-0.11
$corr(T, Y)$	0.85	0.78	0.20
$corr(\tau, Y)$	-0.23	-0.31	-0.11
$corr(G, Y)$	0.91	0.93	0.99

6 Conclusion

This paper proposes a novel mechanism linking financial market frictions to procyclical government expenditure. Empirical evidence has shown that fiscal policy is procyclical in emerging economies, while it is countercyclical in developed countries.

We build an incomplete markets model with redistributive transfers, taxes and public goods. Public goods are valued by households, and redistributive transfers are motivated by earnings inequality. In the model, the government finances expenditures with distortionary taxation and by issuing non state contingent one period bonds in external debt markets.

Transfers play two roles: (i) the redistribution of income, which can also be viewed as the partial insurance against idiosyncratic shocks. (ii) To help consumption smoothing of low income households across aggregate states. Limited market access or the expectation thereof due to a lack of procyclical saving shuts down the second role, and transfers are procyclical.

We simulate the model with a calibration to Brazil to show that default risk indeed drives the qualitative difference in transfer policy over the business cycle. Close to the borrowing constraint, international borrowing and saving cannot help to smooth the tax cost over the business cycle and transfers become procyclical. Procyclicality of transfers is higher the tighter is the borrowing constraint for the government. Consistent with the recent literature on financial market imperfections and fiscal policy, we find that tax policy is also procyclical due to the borrowing constraint. However, the effect is much stronger than on taxes. Lastly, we find that, consistent with cross-country data, transfer spending falls by more than public good spending when the economy faces borrowing constraints.

During these episodes, consumption inequality also becomes counteryclical.

We show that endogenous default risk can rationalize the way that fiscal policy is set over the business cycle. We thus contribute to recent literature that documents the role of procyclical transfers in explaining business cycle features of emerging markets and developing countries.

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7 Appendix

7.1 Ratings

Table 6: Ratings Conversion

S&P / Fitch		Moody's	
AAA	20	Aaa	20
AA+	19	Aa1	19
AA	18	Aa2	18
AA-	17	Aa3	17
A+	16	A1	16
A	15	A2	15
A-	14	A3	14
BBB+	13	Baa1	13
BBB	12	Baa2	12
BBB-	11	Baa3	11
BB+	10	Ba1	10
BB	9	Ba2	9
BB-	8	Ba3	8
B+	7	B1	7
B	6	B2	6
B-	5	B3	5
CCC+	4	Caa1	4
CCC	3	Caa2	3
CCC-	2	Caa3	2
CC	1	Ca	1
C	0	C	0
RD	0		

7.2 Descriptive Stastitics

Table 7: Descriptive Statistics by Country

	GDP (in %)	Tot. Expenditure	Transfers	G.Con	Mean Rating	Rating St.Dev.
		(in % of GDP)				
Argentina	2.30	21.17	6.13	1.68	4.92	2.19
Austria	1.44	50.72	22.19	5.87	18.94	0.86
Belgium	1.25	51.67	22.39	3.98	18.65	0.48
Bolivia	2.23	21.27	3.74	4.26	6.42	1.19
Brazil	1.65	26.23	8.33	2.44	8.33	2.19
Canada	1.32	42.46	9.56	8.35	19.47	0.69
Chile	3.77	21.11	4.81	2.66	14.53	1.42
Czech Republic	2.40	36.72	16.32	3.59	14.53	1.40
Denmark	1.20	54.60	18.40	8.31	19.52	0.52
Dominican Republ	3.65	12.24	0.74	2.00	6.45	1.17
Finland	1.25	50.51	19.36	8.95	19.38	0.92
France	1.00	51.83	23.32	5.10	19.85	0.42
Germany	1.38	46.81	24.53	3.87	20.00	0
Greece	0.63	46.85	17.01	5.64	11.32	4.37
Hungary	2.44	50.80	16.73	7.69	11.91	1.89
Iceland	1.47	40.56	6.25	10.46	14.94	2.48
Ireland	3.47	36.69	12.42	5.07	17.68	2.68
Israel	1.81	43.58	12.26	9.39	14.09	1.41
Italy	0.36	48.72	19.64	4.88	16.79	1.96
Luxembourg	2.02	37.48	19.44	3.38	20.00	0
Netherlands	1.47	44.81	19.59	6.18	19.97	0.09
Poland	4.15	43.44	17.30	6.48	13.25	1.34
Portugal	1.06	43.93	15.75	4.74	15.73	3.11
Romania	3.45	33.85	10.83	6.62	9.02	2.18
Slovak Republic	3.90	43.20	17.05	6.02	12.96	2.66
Spain	1.13	39.61	15.57	4.57	17.76	2.53
Sweden	1.48	52.08	17.55	7.42	19.27	0.99
Thailand	3.35	17.09	1.74	5.33	12.91	1.40
United Kingdom	1.48	41.09	13.31	9.77	19.92	0.22
Uruguay	2.92	26.82	12.82	3.72	9.11	2.17
Total	1.95	40.17	14.44	5.84	15.45	4.74

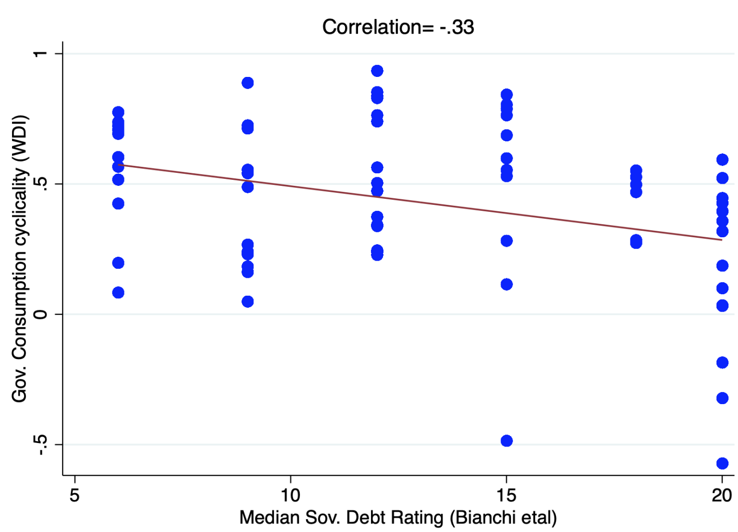
Source: Own calculations based on Michaud and Rothert (2018).

7.3 Additional Empirical Findings

Here we extend the analysis in Figure 3 of the cyclicality of government consumption in a larger dataset. Bianchi et al. (2021) show that countries with lower ratings are more procyclical in terms of their government consumption. We on the other hand, find that that government consumption cycliality is weakly correlated with country's rating. Our papers use different datasets and different methodologies. To facilitate comparison, we apply our method to the data used in Bianchi et al. (2021). We use the sample of countries and their mode ranking listed in their Table J.3. We collect the data for those countries from the WDI: government consumption in per cent of GDP (series NE.CON.GOVT.ZS) and GDP per capita in constant local currency prices (series NY.GDP.PCAP.KN). This leaves us with the sample of 72 countries in the years 1980-2016.

We caluate cyclical components of both series by removing the linear-quadratic trend from each. Next we calculate cyclicality with a correlation coefficient between both series for each country. Next, in the Figure 9 we scatterplot cyclicalities against mode ratings. Note, that this another, albeit quite minor difference in the data treatment: while we use average rating across years and three sources, Bianchi et al. (2021) use mode rating.

Figure 9: Cyclicality of government consumption and country rating



Source: Own calculations based on Bianchi et al. (2021) and World Bank (2021).

7.4 Optimal policy with full insurance

This section proves that optimal policy is countercyclical.

Suppose again that

$$u(c,h) = \frac{(c - \chi\frac{h^{1+\phi}}{1+\phi})^{1-\gamma}}{1-\gamma}, \qquad v(g^P) = \frac{g^{P\,1-\gamma}}{1-\gamma}.$$

Consider first the condition on the behaviour of taxes. If the (normalized) elasticity of taxes is equal to 1, this implies that

$$\begin{aligned} \frac{\partial h^i}{\partial A} &= \frac{\partial h^i}{\partial A} + \frac{\partial h^i}{\partial \tau}\frac{\partial \tau}{\partial A} \\ &= \frac{1}{A}\phi h \left(1 - \frac{\tau}{1+\tau}\underbrace{\frac{\partial \tau}{\partial A}\frac{A}{\tau}}_{=\xi_{\tau,A}}\right) \\ &= 0. \end{aligned}$$

Here the government fully undoes the consumption fluctuations implied by fluctuations in A. However, such policy implies a convex deadweight loss and can thus not be optimal. (Neither can be the case when $\xi_{\tau,A} > 1$, which would imply output that is negatively related to productivity.)

In the following, we assume the earnings ratio is such that the government wants to give out positive insurance payments. Starting from the risk sharing condition under full insurance,

$$\sigma \Delta u_c(c^h, h^h) = -(1-\sigma)\Delta u_c(c^l, h^l), \tag{24}$$

We establish that the optimal policy is indeed countercyclical. Denote the effective insurance payment $\tilde{g}^T = \frac{g^T}{(1+\tau)}$ and consider a marginal change in A, and define as the normalized elasticity of the tax rate with respect to A: $\tilde{\xi}_{\tau,A} \equiv \frac{\tau}{1+\tau}\xi_{\tau,A}$. Under the proposition, this gives

$$
\begin{aligned}
\frac{\partial MUC(h)}{\partial A} &= -\gamma MUC(h)^{1+\gamma}\left(\left(\frac{Ae^h}{(1+\tau)}\right)^{1+\frac{1}{\phi}} A^{-1}\left[1-\tilde{\xi}_{\tau,A}\right]+\frac{\tilde{g}^T}{A}\left[\xi_{T,A}-\tilde{\xi}_{\tau,A}\right]\right)\\
&\overset{!}{<} 0\\
\frac{\partial MUC(l)}{\partial A} &= -\gamma MUC(l)^{1+\gamma}\left(\left(\frac{Ae^l}{(1+\tau)}\right)^{1+\frac{1}{\phi}} A^{-1}\left[1-\tilde{\xi}_{\tau,A}\right]+\frac{\tilde{g}^T}{A}\left[\xi_{T,A}-\tilde{\xi}_{\tau,A}\right]\right)\\
&\overset{!}{>} 0.
\end{aligned}
$$

After rearranging,

$$
\begin{aligned}
\left(\frac{Ae^l}{(1+\tau)}\right)^{1+\frac{1}{\phi}} A^{-1}\left[1-\frac{\tau}{1+\tau}\xi_{\tau,A}\right] &< \frac{\tilde{g}^T}{A}\underbrace{\left[\tilde{\xi}_{\tau,A}-\xi_{T,A}\right]}_{\equiv -\xi_{\tilde{g}^T,A}}\\
&< \left(\frac{Ae^h}{(1+\tau)}\right)^{1+\frac{1}{\phi}} A^{-1}\left[1-\frac{\tau}{1+\tau}\xi_{\tau,A}\right]. \quad (25)
\end{aligned}
$$

Since $\xi_{\tau,A} < 1$, this condition holds as long as $e^l < e^h$ and implies that

$$
\xi_{\tilde{g}^T,A} < 0 \qquad \Leftrightarrow \qquad \frac{\partial \tilde{g}^T}{\partial A} < 0. \quad (26)
$$

In other words, the tax rate reacts stronger to changes in productivity than the insurance payment.

7.5 Optimal policy in autarky

The solution to the autarky case under the functional forms used in the remaining analysis can be shown using guess and verify. Consider the setup of the model without access to external financial markets. Suppose that

$$
u(c,h) = \frac{(c-\chi\frac{h^{1+\phi}}{1+\phi})^{1-\gamma}}{1-\gamma}, \qquad v(g^P) = \frac{g^{P\,1-\gamma}}{1-\gamma}.
$$

Then the following policy rules satisfy the first order conditions to the Ramsey problem:

1. $\tau(A) = \bar{\tau}$
2. $g^T(A) = \bar{g}^T A^{\frac{1}{\phi}+1}$

3. $g^P(A) = \bar{g}^P A^{\frac{1}{\phi}+1}$

Combine the budget constraint of households and the government to obtain:

$$\bar{g}^P A^{\frac{1}{\phi}+1} + \frac{\bar{g}^T}{1+\bar{\tau}} A^{\frac{1}{\phi}+1} = \frac{\bar{\tau}}{1+\bar{\tau}} A^{\frac{1}{\phi}+1} \chi^{-\phi^{-1}} \left[\sigma e^{l\,1+\phi} + (1-\sigma) e^{h\,1+\phi}\right],$$

which is proportional to $A^{\frac{1}{\phi}+1}$, because c^i, h^i are proportional to it as well, and thus holds for all A with the policy rules.

Similarly,

$$u_c^i(c^i, h^i) = \left(\left(\frac{Ae^i}{1+\bar{\tau}}\right)^{\frac{1}{\phi}+1} \chi^{-\phi^{-1}} + \frac{\bar{g}^T}{1+\bar{\tau}} A^{\frac{1}{\phi}+1}\right)^{-\gamma}, \quad u_g(g^P) = \left(\bar{g}^P A^{\frac{1}{\phi}+1}\right)^{-\gamma}$$

are proportional in $A^{-\gamma(1+\phi)}$, and thus hold for all A. Analogously to the last two steps, the first order condition for taxes holds because of the proportionality of marginal utilities and optimal household choices.

7.6 Solution algorithm

The incomplete markets model is solved by value function iterations using the two-loop algorithm suggested by Hatchondo et al. (2010). The model is solved using Matlab. The estimation os the model is conducted by repeating the following steps:

1. Set up numerical values for parameters as in Table 2. We use $n_I = 5$ individual productivity types.

2. Discertize aggreggate TFP using Tauchen and Hussey (1991) procedure with $m = 2.5$ and $n_S = 41$ grid points. TFP values in logs are spaced linearly.

3. Set up the grid for aggregate TFP in the default state.

4. Set up the grid for the assets between $b_{min} = -0.04$ and $b_{max} = 0.15$ with $n_B = 1001$ points spaced logarithmically.

5. Solve for optimal taxes and transfers over the grid on current account:

   (a) Set up the grid for current account, with $n_{CA} = 2001$ grid points, $ca_{min} = -(b_{max} - b_{min})$ and $ca_{max} = b_{max} - b_{min}$. Current account levels are spaced linearly. For the stability of the algorithm the grid is divided into two separate parts: one for positive and one for negative current account levels.

(b) For each aggregate productivity state:

   i. Calculate the autarky solution: use autarky productivity and $ca = 0$. We use `fsolve` over the function that calculates errors in conditions 17 and 18. The `fsolve` procedure returns the optimal values for tax and transfer for each aggregate TFP level.

   ii. Using optimal tax and transfer values calculate auxiliary variables: hour worked, consumption, labour income, and total income for each productivity type and GDP, public good expenditure g^P, and tax income on aggregate level.

   iii. Calculate incomplete markets solution for the positive current account levels as in 5(b)i and 5(b)ii.

   iv. Check if the numerical solution is permissible: public good expenditure is non-negative, tax is less that one, solution is not imaginary, private consumption is positive.

   v. Calculate incomplete markets solution for the negative current account levels as in 5(b)i and 5(b)ii and check conditions as in 5(b)iv.

   vi. Calculate the complete markets solution.

6. Initialize matrices for value function iterations: prices $q0_{n_B \times n_S}$, value functions $V0_{n_B \times n_S}$, "large" matrices for different combinations of assets today and tomorrow: for prices $QQ_{n_B \times n_B n_S}$, taxes $\tau\tau_{n_B \times n_B n_S}$, transfers $TT_{n_B \times n_B n_S}$, public good provision $GG_{n_B \times n_B n_S}$, and "large" matrices that account for different individual productivities for: hours worked $HH_{n_B \times n_B n_S \times n_I}$ and consumption $CC_{n_B \times n B n_S \times n_I}$ and a number of auxiliary matrices.

7. Guess $q0$: discount price for each debt (asset) level in each aggregate TFP state. As initial guess use risk-free discount price, or a user supplied result from previous runs to increase efficiency. Guess the initial value function $V0$.

8. Solve for equilibrium discount prices for debt q^* by value function iterations. Repeat the following steps until $q0 \approx q1$:

(a) For each level of assets today and tomorrow, and for each level of aggregate TFP today: populate matrices $\tau\tau$ and TT with the correspoinding results from step 5.

(b) For each level of assets today and tomorrow, for each level of aggregate TFP today and for each level of individual productivity: populate matrices HH and CC using equations 12 and 13 and results on $\tau\tau$ and TT from the previous step.

(c) For each level of assets today and tomorrow, and for each level of aggregate TFP today calculate GG from equation 7.

(d) Calculate value in default Vd by iterating on equation 9. Note that no numerical maximization is taking place at this step, as optimal decisions for τ, g^T, g^P in autarky are calculated before.

(e) Calculate value in repayment Vnd by iterating on equation 6. In each iteration step the optimal choice of future assets is updated.

(f) Calculate $V1 = max\{Vd, Vnd\}$. This gives the choice default choice matrix $D_{n_B \times n_S}$.

(g) Update the guess $V0 := V1$.

(h) Calculate discount price for debt $q1$ using default choice matrix D.

(i) Check if $q0 \approx q1$. If yes, end iterations. If not, update the guess $q1 := q0$ and go back to step 8a.

9. Using solution from 6 calculate optimal net foreign assets NFA policy.

10. Calculate optimal taxes and trasfers for each assets and aggregate TFP level by interpolating solution from the current account grid (step 5) onto the asset grid using the NFA policy.

11. Simulate the model for 1000 periods 50 times. Discard the first 50 observations.

12. For each simulation period calculate ratios (e.g. debt-to-GDP) and transform level variables into logs (e.g. output, consumption, government expenditures,...)

13. For each simulation run calculate stastics: averages, standard deviations, correlations and autocorrelations.

14. Average stastics across all simulation runs.

15. Adjust parameters.

7.7 Additional Graphs

Figure 10: Tax rate as a function of asset holdings in the risky (left) and safe economy (right).

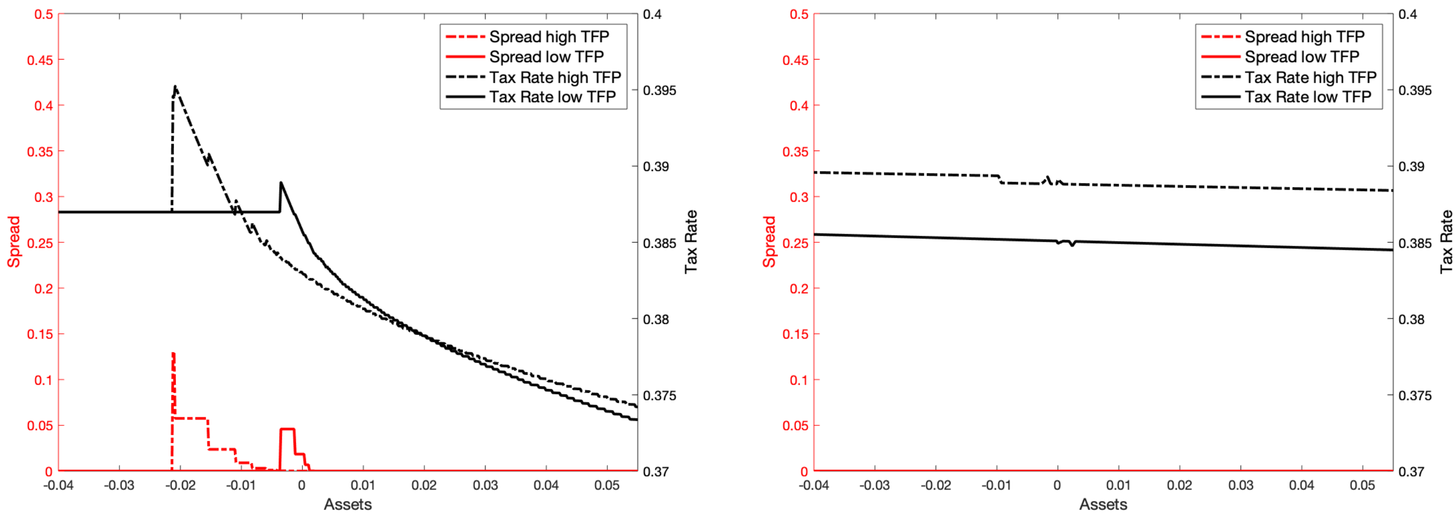


Figure 11: Public good spending as a function of asset holdings in the risky (left) and safe economy (right).