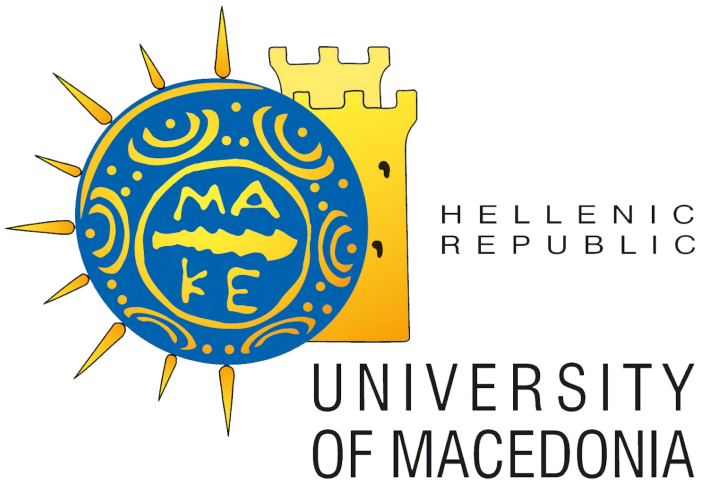

Up to Date Literature Review on Optimal Public Debt and Economic Growth

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Abstract

This is a collection of notes on sovereign debt. The goal is to understand the literature on sovereign debt, and to understand the role of sovereign debt in the macroeconomy. Sovereign debt is a fascinating part of the international economics literature, and is becoming more and more relevant today: the first strand of the literature begun after the 1970s series of defaults afflicting South American countries, and the literature matured significantly immediately after the 2008-2009 European debt crisis. Since then, great leaps foreword have been made, and at a time of increased interest rates, high indebtedness and risky geoeconomic circumstances, further development in the literature is to be expected and promoted. The paper surveys the theoretical literature since the seminal work of Eaton and Gersovitz (1981), and includes most major work on the matter, including researchers like Christina Arellano, Enrique Mendoza, D'Erasmo and others, and the empirical literature with a specific focus on the strand of literature that investigates the non-linear negative relationship of debt and growth proposed by Reinhart and K. S. Rogoff (2010).

Contents

1 Introduction

Debt and default are important issues in international macroeconomics. The recent European debt crisis and the COVID-19 pandemic have brought these issues to the forefront of economic policy. The literature on optimal public debt and default is vast and has been growing rapidly. This paper aims to provide a comprehensive review of the theoretical literature on optimal public debt and default, and the empirical literature on the effect of debt on economic growth.

The theoretical literature spans more than 40 years, starting with Eaton and Gersovitz (1981). The literature has evolved from over-simplistic assumptions about the nature of sovereign default, such as the permanent exclusion of the defaulting sovereign from the asset market, and can now support the incorporation of sovereign debt into large-scale general equilibrium models with endogenous default costs, growth, and interest rates.

The empirical literature has also grown rapidly in recent years. The much acclaimed paper by Reinhart and K. S. Rogoff (2010), which initiated the debate on the existence and magnitude of a debt-growth nexus, utilizes simple descriptive statistics to reach its conclusions. Since then, rigorous econometric techniques have evolved and are used to test their hypothesis.

In this thesis, these two strands of literature are reviewed. It is aimed as a primer for those who are interested in the topic and want to get a comprehensive overview of the literature. The various research interests that motivated each study, the methods used and the results reached are discussed.

The paper is organized as follows. Section 2 surveys related literature. Section 3 overviews the theoretical literature on sovereign debt and default. Section 4 discusses the empirical literature on sovereign debt and growth. Section 5 concludes.

2 Related Literature

In this part of the thesis, I will present other works that survey the literature on sovereign debt and default, starting with Panizza and Andrea F Presbitero (2013). They survey both the theoretical and empirical literature, with a focus on debt thresholds and non-linearities. They do not focus on models of sovereign default, but rather on models that link debt with future growth. The literature on that matter is considerable, and the main topic of discussion is whether debt has an effect on growth, the channels through which this might be the case and the magnitude of the effect. They conclude that the effect, though likely present and negative, is not substantial. For the empirical literature, they start with Reinhart and K. S. Rogoff (2010) and survey the literature on thresholds and non-linearities. Making these thresholds endogenous is one of the main topics in the literature. Another is controlling for endogeneity in the relationship between debt and GDP growth. On the matter of non-linearity, quadratic terms in the estimated growth regression, panel threshold regression, and structural threshold regression models are described, much like in the present thesis. The authors conclude that debt thresholds are probably a useful inclusion for the modelling of debt and growth. The present thesis offers a more in-depth description of many of the empirical models discussed in Panizza and Andrea F Presbitero (2013).

Stähler (2013) surveys the literature on macroeconomic models of sovereign default, starting with the seminal work of Eaton and Gersovitz (1981). The paper describes many of the common elements of quantitative models of sovereign default and includes a break-down of such a model, along with helpful explanations and examples of extensions. This is a good primer into the literature. Once again, this thesis aims to offer more in-depth description of such models.

Yamin et al. (2023) compile an exhaustive catalogue of empirical studies on the relationship between debt and growth. They include 25 studies from 2012 to 2018 that deal with the relationship between debt and growth, and discuss the theoretical arguments for and against the hypothesised negative relationship. These arguments are the Ricardian Equivalence Hypothesis, which posits that higher government debt due to government spending is counterbalanced by lower savings (and vice versa). According to this hypothesis, debt does not affect growth (debt neutrality). The negative impact can arise due to fiscal imbalances that distort actor's planning. There is also an argument for positive effects of government debt, mainly through the Keynesian fiscal multiplier. Government debt finances fiscal expansions, which can prove beneficial to growth.

Out of the 25 studies, 15 find a negative relationship between debt and growth, 4 find a positive relationship, and 6 find no relationship. The authors conclude that the literature has not yet reached a definitive consensus.

Finally, Heimberger (2023) conducts a meta-analysis of the literature on the relationship between debt and growth. With 816 estimates from 47 studies, the author concludes that the effect of debt on growth is minimal, when controlling for publication bias. The threshold and non-linear relationship hypothesis is not robust to changes in data size, exclusion/inclusion choices and econometric specification changes. The methodology pursued by the paper will be discussed in section 4 of the present.

3 Major Theoretical Advances in Sovereign Debt and Default Literature

3.1 "Debt with Potential Repudiation: Theoretical and Empirical Analysis" by Eaton and Gersovitz (1981)

The major insight of Eaton and Gersovitz (1981) was that sovereign default differs from domestic bankruptcy, in that the former is a strategic decision, while the latter is a decision based on the inability to pay. A government can default without fear of legal ramifications: its lenders cannot force it to liquidate assets to compensate them for their losses. Instead, what the government pays with for its repudiation, is its exclusion from further borrowing. In other words, the government attains a reputation for defaulting and lenders refrain from extending any capital towards it in the future. This approach to government borrowing was innovative at its time.

The paper provides three models of sovereign debt. The first one is quite general and aims at providing a theoretical framework for the analysis of sovereign debt. Many important concepts are considered and many insights of the model have become staples of the literature

since. The model features a government (the borrower) and international lenders. Income is a random variable, and the government uses income and new debt to finance consumption and debt repayment. The government uses debt only for consumption smoothing purposes, not investment: debt has no effect on output. Debt takes the form of single-period, non-state contingent bonds. This means that debt issued at time t matures at time $t+1$, and the repayment amount is not contingent on the state of the economy.

Lenders are risk-neutral and have full information about the state of the economy and, therefore, the probability of default. They impose a credit ceiling, $\bar{b}$, which is the maximum amount of debt they are willing to extend to the government. The government can borrow up to the credit ceiling, but no more. The government can choose to default or repay, and the decision is made by comparing the value of the objective function in the two cases. The value of the objective function in the case of default is given by

$$V^D(y_t) \equiv E[\sum_{\tau=t}^{\infty} \beta^{\tau-t} u(y_\tau - P_\tau)], \tag{1}$$

where P_t is a direct penalty to consumption in the case of default, while the value of the objective function in the case of repayment is given by

$$V^R(y_t, d_t) \equiv \sup_{b_t \in B_t} \{U(y_t + b_t - d_t) + \beta E \max[V^R(y_{t+1}, d_{t+1}), V^D(y_{t+1})]\} \tag{2}$$

where d_t is debt repayment at time t, and B_t is the set of possible debt issuance at time t. If $V^D(y_t) > V^R(y_t, d_t)$, then the government defaults. If $V^D(y_t) < V^R(y_t, d_t)$, then the government repays.

Equilibrium is characterized by the government's optimal decision to default or repay, $V^*(y_t, b_t)$, the amount of new debt issued, $B^*(y_t, d_t)$ and the repayment function, $R^*(b_t)$, which maximize $V^*(y_t, b_t)$ subject to

$$[1 - \lambda^*(R^*(b_t))]R^*(b_t) = (1 + \bar{r})b_t, \tag{3}$$

for all $b_t \in B_t$, where $\lambda^*(R^*(b_t))$ is the probability of default. Lenders expect to break even, so the condition boils down to expected returns must equal the risk-free interest rate.

The authors reach some important conclusions:

1. The probability of default is an increasing function of debt service obligations.

2. The repayment function is increasing and convex over the set of possible debt issuance.

These conclusions are important for the literature thereafter.

The second one is a deterministic model of government borrowing, where the government observes periods of high income followed by periods of low income, relative to trend. By assumption, the government will borrow during periods of low income only, and repay (if it so chooses) in periods of high income. Since all actors have full information about the state of the economy, lenders are able to effectively limit government borrowing to sustainable levels. The government therefore never defaults: debt issued at time t can always be repaid at time $t+1$. Nonetheless, the model reaches some important results:

1. Growth rate and income volatility are positively correlated with the level of debt: a fast-growing economy borrows higher amounts, and a volatile economy borrows more in order to smooth consumption.

2. The debt ceiling imposed by creditors is an increasing function of income volatility, and growth has an ambiguous effect on the debt ceiling.

The third model features stochastic income, which follows a random walk. The government can borrow at times of low income, and repay at times of high income. Default is possible, because lenders will accept to lend at time t to a government amounts only repayable if $y_{t+1} = y^h = 1 - \sigma$, where σ is income volatility. These loans will charge double the interest rate to satisfy the lenders' break-even condition.

Econometric application of the model on a panel of 45 developing countries, with data from 1970 and 1974 is used to determine the relation between debt supply and demand, and a set of country characteristics. As model 2 predicts, income volatility are positively correlated with the level of debt. Growth has a positive effect on some countries' debt issuance (those are assumed to be demand-driven, not borrowing at the credit ceiling), while it has a negative effect for others, who are supply constrained and borrow at the credit ceiling.

The importance of imports is used as a proxy for P_t and is found to be positively correlated with the level of debt. This is in line with the model's prediction that debt is positively correlated with the penalty for default. This has come to be one of the ways to sustain higher indebtedness levels in subsequent papers.

The paper is a seminal work in the literature of sovereign debt. It provides a theoretical framework for the analysis of sovereign debt, and it provides a model that can be used to explain the behavior of sovereign debt in the real world. It is a model that has been used and expanded upon by many researchers.

3.2 Quantitative Models of Sovereign Debt and Default

Arellano (2008) is a model of sovereign debt that builds on Eaton and Gersovitz (1981). Motivated by Argentina's 2001 sovereign default episode, the model aims to incorporate business cycle fluctuations in the analysis of sovereign debt. Specifically, the paper aims to study the relation between a) sovereign risk and b) interest rates, output and consumption, and the trade balance.

The model features a government that can borrow from the international capital market, homogeneous households and risk-neutral lenders. Income is a stochastic process, and the government uses debt to smooth consumption. Households maximize discounted expected utility from consumption. The government borrows by purchasing single-period, non-state contingent bonds, B' at price $q(B', y)$. Consumption is given by

$$c = y + B - q(B', y)B', \tag{4}$$

where y is income, B is the stock of debt, and B' is the amount of new debt issued.

Lenders are risk-neutral and expect to break even in expectation. They have access to capital at the international risk-free rate, r and will extend loans to the government up to

the point where they break even, given default probabilities. Bond prices then must satisfy

$$q(B', y) = \frac{1 - \delta(B', y)}{1 + r}, \tag{5}$$

where $\delta(B', y)$ is the probability of default.

The government has the option to default or repay. The value of the objective function in the case of default is given by

$$v^d(y) = u(y^{def}) + \beta \int_{y'} [\theta v^o(0, y') + (1 - \theta) v^d(y')] f(y', y) dy', \tag{6}$$

where y^{def} is income in the case of default, $v^o(0, y')$ is the value function for the government that can default, and $f(y'y)$ is the transition density of income. The value of the objective function in the case of repayment is given by

$$v^c(B, y) = \max_{B'} \{u(y + B - q(B', y)B') + \beta \int_{y'} v^o(B', y') f(y', y) dy'\}. \tag{7}$$

Importantly, y^{def} is given by

$$y^{def} = \begin{cases} \hat{y} & \text{if } y > \hat{y} \\ y & \text{if } y \leq \hat{y} \end{cases} \tag{8}$$

This formulation allows for higher indebtedness during periods of high income, and makes default more likely in periods of low income. It is needed to deliver the empirically observed default probabilities.

The model, when calibrated to match Argentinian data from 1980 to 2001, delivers the following results:

1. The model is able to match the observed default probabilities of 3% per year.
2. The model delivers positive correlation between interest rates and default probabilities.
3. The model delivers a negative correlation between output and consumption, and the interest rate.
4. Higher consumption volatility relative to output volatility.

The model also produces some counterfactuals: interest rate spreads are much lower than those observed in the dataset, when calibrated to deliver the 3% default probability. This can be mitigated somewhat by introducing risk-averse lenders. The paper cites Lizarazo (2013) (then unpublished) as an attempt to provide a framework to this end.

This paper is an important first step towards dynamic, stochastic general equilibrium models of sovereign debt and default. It preceded a major development in the literature, which was the European debt crisis. Up to 2008-2009, most of the literature focused on LDCs, or "less developed countries" (see Eaton and Gersovitz (1981), Kletzer (1984), Bulow and K. Rogoff (1989)) or "emerging economies" (see Aguiar and Gopinath (2006), Cuadra and Sapriza (2008), Hatchondo and Martinez (2009)). After the 2008-2009 debt crisis, the literature shifted to studying debt dynamics in "advanced economies" (see Ghosh et al. (2013), Bi (2012) and others).

3.2.1 General Equilibrium Models of Sovereign Default

Mendoza and Yue (2012) aim to bridge the gap between business cycle models of emerging economies and sovereign debt models. The paper features a model of sovereign debt and economic fluctuations that is able to match the business cycle properties and default dynamics at the same time. Government and lender behavior is standard, but the model also includes households and two types of firms: intermediate and final goods-producing. The intermediate goods sector only uses labor, while the final goods sector uses labor and intermediate goods, both foreign and domestic, as inputs. A portion of foreign inputs require working capital loans to purchase, and access to those loans is conditional of the government not having defaulted. If the government defaults and is excluded from the international capital market, the final goods sector substitutes these inputs for other domestic or foreign goods. The cost of default then arises from imperfection in substitutability of inputs and from the fact that the intermediate goods sector employs a larger percentage of labor.

Final goods producers employ L_t^f units of labor, and use inputs M_t to produce final output, y according to the production function

$$y_t = \epsilon_t (M(m_t^d, m_t^*))^{a_M} (L_t^f)^{a_L} k^{a_k}, \tag{9}$$

where ϵ_t is a productivity shock, m_t^d is the amount of domestic intermediate goods used, m_t^* is the amount of foreign intermediate goods used, a_M is the elasticity of substitution between domestic and foreign intermediate goods. The use of inputs is determined by an Armington aggregator.

Foreign inputs are of two types: those that require working capital loans, and those that do not. They are represented by a Dixit-Stiglitz aggregator:

$$m_t^* \equiv [\int_{j\in[0,1]} (m_{jt}^*)^v dj]^{1/v}. \tag{10}$$

Crucial to the analysis are the within and between elasticities of substitution. Within elasticity of substitution is the elasticity of substitution between domestic and foreign intermediate goods, and between elasticity of substitution is the elasticity of substitution between the two types of foreign goods.

The intermediate goods sector employs L_t^m units of labor, and uses labor to produce intermediate goods, m_t according to the production function

$$m_t = A(L_t^m)^\gamma, \tag{11}$$

where A is the TFP state of productivity in the intermediate goods sector.

The government is a benevolent social planner that uses debt to finance household consumption. Instead of an exogenous stochastic income realization, the government observes a stochastic TFP shock, ϵ_t. The capital market resembles that of Arellano (2008), with the government purchasing bonds b_t at price $q_t(b_{t+1}, e_t)$.

Lenders are risk-neutral and price bonds to satisfy their break-even condition, given an exogenous, risk-free rate of r^*. Bond prices are therefore given by

$$q_t(b_{t+1}, e_t) = \frac{1 - \delta_t(b_{t+1}, e_t)}{1 + r^*}, \tag{12}$$

where $\delta_t(b_{t+1}, e_t)$ is the probability of default.

Using data from Argentina, for the period 1993-2005, the model predicts that a default episode has the following effects on factor allocation and output:

In the baseline calibration, the amount of imported intermediate goods used decreases by about 90%, while demand for domestic intermediate goods increases by about 10%. The amount of labor employed in the intermediate goods sector decreases by about 2%, while the amount of labor employed in the final goods sector increases by about 6%. The amount of capital employed in the final goods sector decreases by about 10% and, finally, total labor decreases by about 10%. Sensitivity analysis (changing the values of different elasticities) produces intuitive results. Higher "within" and "between" elasticities weaken the effects of default. The better the goods substitute each other, the weaker the effects of default.

Output costs depend positively on the magnitude of the TFP shock and on "within" and "between" elasticities. The larger the TFP shock, the larger the output costs of default. The better the goods substitute each other, the smaller the output costs of default. The baseline calibration, keeping TFP= 1, delivers an output cost of about 5%.

The model matches the business cycle properties of the Argentinian economy, and the default dynamics. The model is able to match the observed default probabilities of about 0.8% on a quarterly basis by producing average spreads of 0.74%, while at the same time producing countercyclical bond spreads and net exports.

The model sets out to offer a better way to approach default cost when modelling sovereign default. While the formulation offered by Arellano (2008) is intuitive and easy to use, it lacks theoretical backing. Mendoza and Yue (2012) offer a model that is able to match the business cycle properties of the economy, and the default dynamics, while at the same time offering a theoretical framework for the analysis of default costs that explains why the cost of default is higher during "good times".

3.3 Bond Duration and Sovereign Default Risk

Arellano and Ramanarayanan (2012) introduces the maturity structure of sovereign debt in the analysis of sovereign default. The paper is motivated by the observation that during crises, the maturity structure of sovereign debt changes. Specifically, governments turn to short-term debt during periods of high interest rate spreads. The proposed explanation is that short-term debt offers repayment incentives, since default leads to (temporary) exclusion. On the other hand, governments prefer long-term bonds during periods of low interest rates, since they offer a hedge against future crises.

The paper features a model of sovereign debt and default, where the government can issue bonds of different maturities: short-term bonds are single-period, non-state contingent bonds, as in Arellano (2008), while long-term bonds are modelled as perpetuity contracts (see Hatchondo and Martinez (2009)) which decay at rate δ.

Government, household and lender behavior is standard, and the penalty for default is temporary exclusion from the international capital market and a direct output cost, given by

$$y_t^{def} = \begin{cases} y_t & \text{if } y_t \leq (1-\lambda)\bar{y} \\ (1-\lambda)\bar{y} & \text{if } y_t > (1-\lambda)\bar{y}, \end{cases} \tag{13}$$

where λ is the penalty for default if income is above a certain threshold, $\bar{y}$. This is a formulation that is based on Arellano (2008), and is needed to deliver the empirically observed default probabilities.

Where the paper differs from Arellano (2008) is in the pricing of bonds. Short-term bond prices are given by

$$q_S(b'_S, b'_L, y) = \frac{1}{1+r^*} \int_{R(b'_s, b'_L)} f(y', y) dy', \tag{14}$$

where $R(b'_s, b'_L)$ is the repayment set, and $f(y', y)$ is the transition density of income. Long-term bond prices are given by

$$q_L(b'_s, b'_l, y) = \frac{1}{1+r^*} \int_{R(b'_s, b'_L)} [1 + \delta q_L(\hat{b_S}(b'_S, b'_L, y'), \hat{b_L}(b'_S, b'_L, y'), y')] f(y', y) dy', \tag{15}$$

where $\hat{b_S}$, $\hat{b_L}$ are the government's policy functions for short-term and long-term debt, respectively. Long-term debt prices not only depend on the debt issued and the transition density of income, but also on future debt issuance. It is therefore more sensitive to changes in the level of debt.

Calibrated using data for Argentina, Brazil, Mexico and Russia, the model delivers lower spreads and debt-to-GDP ratios (2.5% and 16%, respectively, while observed spreads and ratios are about twice that), but matches the observed maturity structure of debt. It is able to accurately portray the co-movements between income, default probabilities and the maturity structure.

3.4 Distributional Consequences of Sovereign Defaults

Motivated by the European debt crisis, D'Erasmo and Mendoza (2016) introduce a model of domestic sovereign default, where debt is held by households. The authors believe this to be a more realistic approach to the European debt crisis, as large portions of the debt of countries with high default probabilities were held by other European entities. Also, the European Central Bank and the European Commission, both responsible for dealing with the crisis, care both about creditors and debtors. A default episode, from their point of view, has redistribution effects on the European economy.

The model proposed is a two-period model with heterogeneous households that differ in their wealth: a portion γ are Low-wealth households and a portion $(1-\gamma)$ are High-wealth. High-wealth households are bondholders. In the baseline calibration, the government is benevolent and weights the two types' utility according to the fraction of the population. In an extension of the model, the government displays bias in favor of bondholders.

Income is non-stochastic, and households use income and bond returns to finance consumption, taxes and bond purchases. In the first period, household consumption is given by

$$c_0^i = q_0 b_0^i = y + b_0^i - \tau_0, \text{ for } i \in \{L, H\}, \tag{16}$$

where q_0 is the price of bonds, b_0^i is the amount of bonds purchased by household of type i, y is income, and τ_0 is the amount of taxes paid. In the second period, consumption is given

by

$$c_1^i = \begin{cases} y + b_1^i - \tau_1 & \text{if repay} \\ (1 - \phi(g_1))y - \tau_1 & \text{if default,} \end{cases} \tag{17}$$

where $\phi(g_1)$ is the output cost of default. It is a function not of income, but of government purchases. The cost of default is exogenous and used to support an equilibrium with debt. In the absence of an output cost of default, the government would never repay. Therefore, it could never borrow.

The government uses tax revenue and debt to finance government purchases and debt repayment. In the first period, the government budget constraint is given by

$$\tau_0 = g_0 + B_0 - q_0 B_1, \tag{18}$$

where B_0 are bond repayments, and $q_0 B_1$ is the amount of new debt issued. In the second period, the government budget constraint is given by

$$\tau_1 = \begin{cases} g_1 + B_1 & \text{if repay} \\ g_1 & \text{if default.} \end{cases} \tag{19}$$

Instead of income being a stochastic process, uncertainty in this model comes from the realization of government purchases, g_t, which the government must finance through taxation and debt. The government passes these purchases to the households through taxes (negative τ_t representing net transfers).

The government can choose to default or repay. The value of the objective function in the case of default is given by

$$W_1^d(g_1) = u(y(1 - \phi(g_1)) - g_1), \tag{20}$$

which equalizes consumption of Low- and High-wealth households. The value of the objective function in the case of repayment is given by

$$W_1^r(B_1, g_1, \gamma) = \gamma u(y - g_1 + b_1^L - B_1) + (1 - \gamma)u(y - g_1 + b_1^H - B_1), \tag{21}$$

which decrease consumption for Low-wealth households, and increase consumption for High-wealth households. This is because, by construction, only High-wealth households hold bonds (since $b_1^L = 0$ by construction, so $b_1^L - B_1 \leq 0$, $b_1^H - B_1 \geq 0$). This is the first part of the model's proposed mechanism for the distributional incentives of default and repayment.

The optimal debt decision is given by

$$W_0(\gamma) = \max_{B_1} \{\gamma v^L(B_1, \gamma) + (1 - \gamma)v^H(B_1, \gamma)\}, \tag{22}$$

where $v^L(B_1, \gamma)$, $v^H(B_1, \gamma)$ are the value functions for Low- and High-wealth households, respectively. Debt issuance is therefore a function of the portion of households that are bondholders: Issuing debt has the redistributive effect of reducing consumption disparities between the two types, since reduces consumption for High-wealth households by the amount of debt they purchase (and the price they purchase it at). This is the second part of the model's mechanism.

The model shows that keeping γ (B_1) constant, an increase in B_1 (γ) increases the probability of default. This is because given γ, intuitively, higher indebtedness entails higher default incentives, given the distributional effects of repayment. On the other hand, given B_1, increasing γ increases the welfare gains of default, since debt is held by fewer households.

The paper explores an extension of the model, where the government can display bias by setting the weights it places on type utilities to be different from the fraction of the population. Therefore, 20, 21 and 22 become a function of ω, the weight the government places on Low-wealth type households.

A government that is biased in favor of Low-wealth households ($\omega_H > \gamma$) always chooses to default, since he prefers $c_L \geq c_H$, which is only possible in the case of default. On the other hand, a government that is biased in favor of bondholders ($\omega_L < \gamma$) has stronger repayment incentives, which allow it to take on more debt. The quantitative predictions of the model show this: debt choice is higher for ω_H than for ω_L and, for relevant values of γ (between 0.55 and 0.85), debt choice is higher for biased governments than for benevolent ones. In fact, the debt levels supported by biased governments in the model come close to those observed in European economies (25% for ω_H, 35% for ω_L).

Interestingly, Low-wealth households are better off in the case of a government that is biased against them, since the lower default probabilities allow for higher debt levels, which in turn allow for higher consumption.

In the same strand, D'Erasmo and Mendoza (2021) return to the question of distributional consequences of sovereign defaults. Once again motivated by the European debt crisis, which they maintain is more appropriately modelled as a domestic debt crisis, this paper offers a more in-depth analysis by moving away from the two-period formulation of D'Erasmo and Mendoza (2016) and incorporating endogenous debt holding dispersion, foreign lender participation and endogenous default costs.

This is a Bawley model with heterogeneous agents who try to insure against idiosyncratic risk by using government bonds to save and share risk between themselves. Agents draw y from a set of realizations $y \in \mathcal{Y} = \{\underline{y}, \bar{y}\}$. Their consumption constraint is given by

$$c_t = \begin{cases} y_t(1-\tau^y) + b_t + \tau^t - q_t b_{t+1} & \text{if repay} \\ y_t(1-\tau^y) + b_t - \phi(g) + \tau^t & \text{if default,} \end{cases} \tag{23}$$

where τ^y is the income tax, τ^t is the lump-sum tax, b_t is the amount of bonds held by the agent, q_t is the price of bonds, g is government purchases, and $\phi(g)$ is the output cost of default. Government purchases are drawn from a set of realizations $g_t \in \mathcal{G} = \{\underline{g}, \ldots, \bar{g}\}$, which is another source of risk for households.

The government makes debt and default or repayment decisions by maximizing the social welfare function, which is a function of the weight the government places on the utility of agents who hold bonds, $\omega(b, y)$. The weight depends on the scale parameter $\bar{\omega}$, the "creditor bias" (higher $\bar{\omega}$ meaning bondholders are more important to the government).

Net transfers are given by

$$\tau_t = \begin{cases} \tau^y Y - g_t - B_1 + q_t B_{t+1} & \text{if repay} \\ \tau^y Y - g_t & \text{if default,} \end{cases} \tag{24}$$

where τ^y is the income tax rate and Y, B_t are aggregate income and debt, respectively. Aggregate income is non-stochastic, as the income shocks have zero mean across agents.

Foreign lenders face a risk-free interest rate $\bar{r}$. They price bonds to satisfy their break-even condition, given the probability of default, $p(B', g)$. Bond prices are therefore given by

$$q_t(B', g) = \frac{1 - p(B', g)}{1 + \bar{r}}. \tag{25}$$

Default probabilities are determined by comparing the social value of default versus repayment: the government internalizes the effects default and repayment has on all domestic actors. The model is able to support an equilibrium with debt, even in the absence of exogenous default costs, if the resulting redistribution from repayment is valued higher than that of default.

Changes in B affect both the price of bonds (thought the effect on default incentives present in all models surveyed) and the distribution of debt holdings. Agents who drew high income realizations will purchase bonds in order to increase their savings, while others will do the opposite. This way agents insure themselves against income risk. But higher bond prices concentrate new purchases into the hands of fewer agents, increasing the redistributive benefits of default. This is the feedback mechanism of the model. The government internalizes these effects when deciding on debt levels and default or repayment.

When calibrated to match moments of eleven European economies (including both ones that experienced severe debt crises, like Greece, and ones that did not, like Germany), the model accurately predicts the default frequency (1.1% against 1.2% in the dataset). In line with empirical observation, spreads are low for most of the period and rise sharply when default approaches. The model also supports high spreads with debt levels close to those observed in the Eurozone: spreads close to 10% might be higher than those experienced by northwestern countries, but they are near those experienced by Greece and Portugal.

The model differs from D'Erasmo and Mendoza (2016) in that it is a continuous time model, which allows for a more in-depth analysis of the distributional effects of default. It incorporates more complicated dynamics, such as endogenous debt holding dispersion, foreign lender participation and endogenous default costs. The main difference is that debt holding dispersion is time-varying, while in D'Erasmo and Mendoza (2016) it had to be taken as a constant.

3.5 Self-fulfilling Sovereign Debt Crises and Institutional Lenders

Galli (2021) introduces many novel features to the analysis of sovereign debt. Motivated by the European debt crisis, he includes fiscal policy into his analysis. This allows him to study the effects of austerity measures, such as those taken by European countries during the debt crisis. The model also introduces lender seniority, an appropriate addition to the analysis of sovereign debt crises, since in many occasions, the International Monetary Fund plays that role.

The model is a two-period model and features a government that uses debt and taxation to finance debt repayment and government transfers (negative taxation). The government can choose to default or repay. The economy is populated by households that finance consumption, taxes and capital accumulation by producing output using accumulated capital.

International lenders are risk-neutral and lend to the government, facing an international risk-free rate. In the case of default, household production suffers a random output loss z_t, with a cumulative distribution function $G(z_t)$.

In period $t = 0$, households have capital k_0 (aggregate capital denoted by K_0), the government has a stock of outstanding debt, B_0 and chooses B_1, T_0. Lenders price bonds to satisfy their break-even condition, and the price of bonds, q_0 is reached. Households observe B_1, T_0, q_0 and form expectations about default probabilities for time $t = 1$. They use these expectations to allocate income between consumption and capital accumulation. Households are atomistic and do not internalize the effect their choice has on output, but lenders internalize the household choice when pricing bonds. This has interesting consequences.

If debt prices are low (high interest rates), the government will substitute debt for taxes, since the cost of debt is high. Households observe higher taxes and lower debt, and expect higher default probabilities. They therefore accumulate less capital. This leads to output dropping, which increases default probabilities. This is the way debt crises become self-fulfilling.

The government chooses to default if the output cost of default is lower than debt-to-GDP ($z_1 < \hat{z} = B_1/f(K_1)$), where $f(K_1)$ is the production function. In the event of a default, lenders recover a portion $\eta z_1/\hat{z_1}$ of their bond holdings. Their break-even condition is given by

$$q_0 = \frac{1}{R}[1 - G(\hat{z_1}) + \int^{\hat{z_1}} \eta \frac{z_1}{\hat{z_1}} dG(z_1)], \tag{26}$$

where R is the international risk-free rate. Since q_0 appears both linearly and non-linearly in 26 (through $\hat{z_1}$, which is a function of K_1, which depends on the bond price households observe), there might be multiple values of q_0 for which the break-even condition is satisfied. This is a major aspect of the model: this allows for coordination failure between lenders, which leads to higher default probabilities through the effect that substitution of debt for taxes has on output.

In the case where two values of q_0 satisfy the break-even condition, one high and one low, two distinct schedules exist: one "good", where the bond price is high, taxes are low, capital accumulation and output is high and default probabilities are low, and one "bad", where the opposite takes place. The government is assumed to know which schedule it is on when making debt decisions by observing market sentiment before the auction.

The assumption of loss recovery allows for the modelling of International Monetary Fund interventions. The Fund in the real world plays the role of a "creditor of last resort", which is able to provide liquidity to countries in distress. The Fund can achieve this by making its involvement conditional on terms, usually fiscal and monetary consolidation. In the model environment, several formulations are proposed to depict IMF interventions.

Full Commitment

Here it is assumed that debt to the IMF is undefaultable. The reasoning behind this is that defaulting on IMF loans carries much higher costs than defaulting on other debt, since it is a signal of bad economic management. Since default is impossible, the government can borrow at the risk-free interest rate, R. This means that debt-to-GDP, bond prices and overall welfare is higher than without full commitment. Since the cost of debt is low, the

government can borrow larger amounts and keep taxes low. In response, households can accumulate more capital by observing lower default probabilities and paying lower taxes.

Full commitment to repayment is a "gold standard" in the literature. It is a benchmark against which other allocations are measured. A technology that would allow for full commitment, when introduced to most models of sovereign default, allows for higher economic performance overall. It is exactly the lack of any such technology that makes default a subject of analysis.

Pari-Passu Lending

Here, the IMF participates on an equal basis with market lenders, but can (given sufficient capital) coordinate lending to the "good" schedule. This is a more realistic scenario. IFM participation only takes place when it has sufficient funds to completely eliminate the possibility of coordination failure, otherwise it exposes itself to sovereign risk without compensating for it. In the extreme case where the IMF has enough capital to cover all the needs of the government, interestingly, it doesn't need to actually participate to coordinate other lenders: the government always prefers IMF loans and the possibility of IMF intervention forces all lenders to coordinate on the "good" schedule automatically.

Seniority

In this formulation, the IMF assumes the position of a senior lender. In the event of default, senior lenders recover their losses with priority over other lenders, who might even get nothing.

This leads to a situation where there are two distinct pricing regimes: one for senior and one for market lenders. The possibility of a coordination failure is still present among market lenders, and the price of debt for the senior lender is higher than that of market lenders. This is not a good approach to IMF intervention: coordination failure probabilities are high and the outcome is worse than that of *Pari-Passu* lending.

While not offering any empirical application of the model, the paper is an important contribution to the literature. The inclusion of self-fulfilling expectations and coordination failure is a novel approach to the analysis of sovereign debt crises. IMF and senior lender involvement is also a rare inclusion, and one that is useful in understanding how debt crises are handled today.

Fink and Scholl (2016) also include International Financial Institutions to their analysis. In their model, IFIs provide better terms but require macroeconomic consolidation. The government can negotiate a bailout instead of defaulting, by restricting its policies on government spending or taxation. Calibrated to the Argentinian economy, the model predicts that IFI involvement reduces defaults in the short-run, but might increase default probabilities in the long-run, because the government incurs more and more debt as a result of the higher bond prices it enjoys.

Self-fulfilling debt crises can also arise from lender expectations, such as in Aguiar, Chatterjee, et al. (2022). In this paper, which builds on earlier work by Cole and Kehoe (2000), the authors take a more microscopic view into the auction mechanism. The model allows for government to default on its current debt immediately after it issues new debt. This decision

is based on information that becomes available to the model actors after the bond prices have been set. This introduces "intra-period" risk into the economy, and lender expectations about this information play a major role in determining prices.

The model economy, interestingly, is a single-period economy where the government has existing debt B, observes a stochastic realization of income, Y, and decides on B'. Lenders observe the state of the economy, s, and price the bonds at $q(s, B')$. The government decides on default by comparing V^R, V^D. In the case of default, however, the government's payoff is not V^D, but $V^D + \sigma\epsilon$, where ϵ is a random variable, independently and identically distributed and whose distribution function is $F(\epsilon)$. This gives rise to intra-period risk into the economy, which lenders internalize in their decision to price bonds. The government in turn internalizes lenders' response.

The government defaults if and only if

$$V^D + \sigma\epsilon > V^R, \tag{27}$$

If $\mathcal{B}$ is the government's optimal policy function for B', then the price function for bonds is

$$q(s, B') = R^{-1}F(\sigma^{-1}\Delta(s, B'))E[F(\sigma^{-1}\Delta(s', \mathcal{B}))|B'], \tag{28}$$

where $\Delta(s, B')$ is the difference between the government's payoff in the case of repayment versus default, and s' is the state of the economy in the next period. Bond prices depend on default probabilities today, $F(\sigma^{-1}\Delta(s, B'))$ and next period, $EF(\sigma^{-1}\Delta(s', \mathcal{B}))$.

Let q_{EG} denote the price of bonds if the government could commit to not defaulting on B (but not on B'). This represents a higher bound for bond prices. Now, let $\hat{q}$ denote some price that might satisfy the lenders' break-even condition. Then, $\hat{\Delta}$ denotes the difference between the value of repaying and the value of default for $q = \hat{q}$. The probability of default is $F(\sigma^{-1}\hat{Delta}) \equiv \hat{F}(\hat{q}/q_{EG})$. The equilibrium condition is

$$\hat{F}(\hat{q}/q_{EG}) = \hat{q}/q_{EG}. \tag{29}$$

Equation 29 can have multiple solutions. $\hat{q} = q_{EG}$ completely removes the possibility of default on B, but, the government, in order to attain that price, over-borrows compared with the optimal amount without intra-period risk. This is because the government borrows amounts that assure lenders B will be repaid after the auction.

When $\hat{q} = 0$ is a solution, default is a certainty. This is the equilibrium assessed by Cole and Kehoe (2000). The auction fails. The government defaults and is barred from issuing new debt for a stochastic period of time.

Finally, there are cases where -perhaps multiple- internal solutions exist for a certain $\hat{\epsilon} \in [0, 1]$. In that case, there is uncertainty about whether the government will default or repay, since the actual realization of ϵ becomes known after q has been decided. This is where self-fulfilling crises and coordination failure arise. Lenders might coordinate on a low price, forcing a default. The government responds to that either by overborrowing, thus increasing the probability of default in the long run, or by issuing less debt and suffer the effects of this austerity.

Lenders form expectations about the government decision based on their type, which is formed exogenously. They can be of three types: "optimists", who coordinate on the highest

possible price, "pessimists", who coordinate on the lowest possible price, and "concerned", who coordinate on the highest possible among internal solutions, if and when they exist (otherwise, they behave as optimists).

With "concerned" lenders and internal solutions, the government repeatedly overborrows in order to avoid the lower prices that result from lender expectations. This leads to prolonged periods of increasing default probabilities.

The model, calibrated to match Mexican data from 1980 to 2020, either over-predicts or under-predicts default probabilities, depending on the type of debt that is assessed. A model with one-period bonds under-predicts default (with default occurring once every 200 years), while a model with long-term bonds over-predicts them (once every 20 years).

The model also connects with the literature on the effects of institutional lenders. The authors show that ϵ is a good way to proxy the magnitude of a bailout by the IMF or similar institutions: the larger the bailout agreed upon by the government and the institutional lender, the larger the default probability and thus intra-period risk. This offers a quite unique perspective on this matter.

4 Empirical Treatment of the Relationship between Sovereign Debt and Economic Growth

The literature on the relationship between sovereign debt and economic growth is vast. The papers surveyed in this section offer a good overview of the different approaches to the analysis of this relationship.

4.1 Some Early Empirical Work

De Haan and Sturm (1994) use a panel of 12 European Community countries, with observations from 1981 to 1989 to study the effects of various political determinants of public debt. They test how power dispersion (whether the government is a majority, coalition, or a minority government), political change (the frequency of government changes), ideological orientation and budget procedures (the structure of budget negotiations, based on Hagen (1992)) affect the fiscal policy of 12 European Community member countries, using data from 1981 to 1989. They estimate the following specification:

$$\delta BY = \alpha_0 + \alpha_1 \Delta BYL + \alpha_2 \Delta UB + \alpha_3 \Delta RB + \alpha_4 \Delta GR + \alpha_5 P + v,$$

where ΔBY denotes the change in government debt-to-GDP, ΔBYL denotes the change in government debt-to-GDP in the previous period, ΔUB denotes the change in the unemployment rate, ΔRB denotes the change debt-servicing cost, ΔGR denotes the change in the growth rate of real GDP, P is a vector of political variables, and v is the error term.

The authors hypothesise that all political variables are significant and that political change, power dispersion and ideological orientation have a positive effect on debt-to-GDP, while budget procedures have a negative effect. They find that power dispersion is not a significant determinant of debt choice, as is also the case for ideological orientation. What is significant, is budgeting procedures (if one removes Luxembourg from the sample, as is

often practice) and political change. Budgetary procedures seem to explain at least part of the differences between countries' debt policies. The frequency of government change also is significant, and a positive relationship exists between it and debt-to-GDP.

Chowdhury (1994) applies Granger causality tests to a panel of Asian countries (Bangladesh, Indonesia, Malaysia, Philippines, South Korea, Sri Lanka, Thailand) to test the hypothesis that debt causes growth or, instead, if lack of growth causes high debt.

To test the causal effects of debt on growth (and vice versa), the author uses the following specification:

$$y_t = \ln GNP_t - \ln GNP_{t-1} = g + u_t, \tag{30}$$

$$x_t = \ln TED_t - \ln TED_{t-1} = h + v_t, \tag{31}$$

where y_t is the growth rate of GNP, x_t is the growth rate of total external debt, g and h are GNP and debt growth rates, and u_t and v_t are error terms with zero mean and $2\sigma_j^2$ variance, $j = \{1, 2\}$ (1 for 30, 2 for 31).

The null hypotheses of debt causing growth and growth causing debt are tested for each country. It is shown that unilateral causation flows from debt to growth for Bangladesh, Indonesia and S. Korea, the reverse is true for the Philippines, a feedback is observed for Malaysia and the Philippines (at the 5% level of significance) and no causal relationship is observed for Sri Lanka and Thailand. Unsatisfied with these results, a structural simultaneous equation model is constructed, comprising of the following equations:

$$Y = a_0 + a_1 D_{it} + a_2 DP_{it} + a_3 K_{it} + a_4 K_{it}^2 + a_5 L_{it} + a_6 L_{it}^2 + a_7 AG_{it} + \epsilon_{1it}$$

$$K_{it} = b_0 + b_1 Y_{it} + b_2 D_{it} + b_3 DP_{it} + b_4 K_{it-1} + b_5 AG_{it} + b_6 P_{it} + b_7 IN_{it} + \epsilon_{2it}$$

$$D_{it} = c_0 + c_1 Y_{it} + c_2 D_{it-1} + c_3 AG_{it} + c_4 TT_{it} + c_5 INSH40_{it} + \epsilon_{3it}$$

$$DP_{it} = d_0 + d_1 Y_{it} + d_2 P_{it-1} + d_3 AG_{it} + d_4 TT_{it} + \epsilon_{4it}$$

where Y is gross national product, K is the capital stock, D is the public external debt, DP is private external debt, L is labor, AG is percentage of labor in agriculture, P is the population and IN a proxy for economic inequality. Using 3SLS, the author reaches the conclusion that an increase of 1% in the GDP raises public debt by 0.4%. On the other hand, an 1% increase in the public debt raises GDP by 0.24%.

Pasinetti (1998) evaluates the validity of the Maastricht Treaty's convergence criteria for the European Union. The criteria are that the budget deficit should be less than 3% of GDP and the debt-to-GDP ratio should be less than 60%. The author shows that, instead of representing a well-justified sustainability criterion, the 3%/60% ratios represent just one point in a sustainability area, and accuses their selection as arbitrary. Furthermore, he provides evidence that, when evaluating the sustainability area, only two EC member states meet the conditions for sustainability. These nations are exactly the nations with the largest divergence from the 3%/60% ratios, namely Italy and Belgium.

Starting off, Pasinetti (1998) defines a sustainability area as the set of all possible combinations of debt and deficit that satisfy the following condition:

$$\theta \leq g,$$

where θ is the growth rate of public debt, and g is the growth rate of GDP. He then defines budget surplus and primary surplus,

$$S = -\Delta D$$

$$S^p = R - G,$$

and shows that the sustainability condition can be written either as

$$S/Y \geq -g(D/Y)$$

or as

$$S^p/Y \geq (i - g)(D/Y),$$

where i is the interest rate on public debt, Y is GDP and D is public debt. Using his definition, primary surpluses are an increasing function of interest rates. Faced with higher interest rates, the government has to run higher surpluses to remain in the sustainability area. Whether surpluses are an increasing or decreasing function of debt is determined by the growth rate of GDP. If the growth rate is positive, a government can respond to rising debt by decreasing surpluses. On the other hand, if an economy is contracting, the government has to run higher surpluses if the debt rises.

Ardagna (2004) aims to identify the determinants of successful and expansionary fiscal adjustments. Fiscal adjustments are deemed successful, if they manage to reduce the debt-to-GDP ratio, and expansionary if they lead to higher growth in the long-run. The author further attempts to evaluate the relative validity of the two main theories about what the channel through which fiscal shocks are absorbed. One point of view maintains that it is through actor expectations (tight fiscal policy today means less need for further tightening tomorrow), while another favors the labor channel (tighter fiscal policy puts less pressure on wage demands, strengthening employment and capital accumulation). The author inspects the composition (whether it is through tax increases or expenditure cuts) and overall size of the adjustment and the effect these two variables have on the success of the adjustment.

To test the probability of a successful adjustment, the author uses the following probit specification:

$$\begin{aligned} s^*_{it} = {} & \theta_{1i} + \gamma y_{it-1} + \alpha_{11}\Delta G_{it} + \alpha_{12}\Delta T_{it} + a_{13}DEF_{it-1} + \alpha_{14}DEB_{it-1} \\ & + \alpha_{15}Left_{it} + \alpha_{16}Center_{it} + \alpha_{17}Major_{it} + u_{1it} \end{aligned} \tag{32}$$

$$s_{it} = \begin{cases} 1 & \text{if } s^*_{it} > 0, \\ 0 & \text{otherwise,} \end{cases} \tag{33}$$

where G is the (cyclically adjusted) primary expenditure-to-GDP ratio, T is the tax rate, DEF is the deficit, DEB is public debt, $Left$, $Center$ are political ideology dummies and $Major$ is a coalition government dummy. s then signifies an adjustment that lead to the reduction of the debt-to-GDP ratio by an arbitrary percentage two years after the adjustment, controlling for other variables. s is then used as a regressor in the per capita GDP growth regression

$$\begin{aligned} y_{it} = {} & \theta_{2i} + \gamma_2 s^e_{it} + \alpha_{21}\Delta G_{it} + \alpha_{22}\Delta T_{it} + \alpha_{23}DEF_{it-1} + \alpha_{24}DEB_{it-1} \\ & + \alpha_{25}y_{it-1} + \alpha 26 y^{G7}_{it-1} + u_{2it}, \end{aligned} \tag{34}$$

where y_{it}^{G7} is the GDP-weighted average per capita GDP of the G7 nations. Using this specification, one can check the validity of the expectations view: a significant and positive γ_2 is evidence that people's expectations about the ability of the government to adjust plays a role in determining whether an adjustment has a positive effect on long-term growth. This equation is estimated by OLS.

A simultaneous equation specification is also estimated, to incorporate any chance of endogeneity. The model is

$$\begin{aligned} s_{it}^* = \theta_{1i} + \gamma y_{it} + \alpha_{11}\Delta G_{it} + \alpha_{12}\Delta T_{it} + a_{13}DEF_{it-1} + \alpha_{14}DEB_{it-1} \\ + \alpha_{15}Left_{it} + \alpha_{16}Center_{it} + \alpha_{17}Major_{it} + u_{1it} \end{aligned} \tag{35}$$

and the growth equation is given by 34. The model is estimated with Amemiya's generalized least squares (AGLS) (Amemiya (1978)).

Light modifications to 32 allow for checking the relative strength of adjustment composition and size. Specifically, to capture the effect of composition and size of the adjustment, the following specification can be used:

$$\begin{aligned} s_{it}^* = \theta_{1i} + \gamma y_{it-1} + b_{21}(\Delta G_{it} - \Delta T_{it}) + b_{22}(\Delta G_{it} + \Delta T_{it}) + a_{13}DEF_{it-1} \\ + \alpha_{14}DEB_{it-1} + \alpha_{15}Left_{it} + \alpha_{16}Center_{it} + \alpha_{17}Major_{it} + u_{1it} \end{aligned} \tag{36}$$

b_{21} captures the effect of composition and b_{22} the effect of overall size.

Using data from 17 OECD countries, for the period of 1975 to 2002, the paper concludes that size and composition affect the formation of expectations (equation 32), with size playing the major role. Debt-to-GDP reduction is more likely, when the size of the adjustment is large. The role of composition is still important, although less so. As for the effect on growth, both size and composition are important. The expectations view is not validated: s^* is not a significant determinant for growth. Instead, the paper favors the labor market channel view, which holds that fiscal tightening affects long-run growth through incentivizing employment and capital accumulation.

4.2 Reinhard and Rogoff, Non-linearity and the 90% Threshold

In a now infamous paper, Reinhart and K. S. Rogoff (2010) use descriptive statistics to show that debt-to-GDP ratios above 90% are associated with lower growth. The authors explore a new dataset, containing debt data for advanced and emerging economies, which they split into 4 categories, based on debt-to-GDP ratios: less than 30%, between 30 and 60%, between 60 and 90% and over 90%. They then compute the average growth rate of each category and reach the conclusion that growth in the over-90% debt-to-GDP category is significantly lower than the rest. They pose that this ratio of 90% is the threshold, over which growth is negatively affected by debt.

While this paper was met with enthusiasm, it was also met with criticism. Herndon, Ash, and Pollin (2014) replicate the results of Reinhart and K. S. Rogoff (2010) and find that the results are not robust to minor changes in the data. They find that the average growth rate of the over-90% category is not significantly different from the rest. They also find that the results are not robust to the inclusion of more recent data.

Specifically, Herndon, Ash, and Pollin (2014) show that Reinhart and K. S. Rogoff (2010) selectively excluded data, use faulty code and inappropriate weighting schemes. New Zealand, Canada and Australia were excluded from the analysis for the years after World War II, when these countries were experiencing high growth while at the over 90% debt-to-GDP category. This exclusion is neither mentioned nor justified in the paper. Their exclusion seems unjustifiable, since the United States was not excluded for the years after World War II, when it too was in the 90% debt-to-GDP category but was experiencing contraction. The original paper also contained a coding error, which resulted in the exclusion of five countries from the analysed dataset. Furthermore, the weighting methodology used was deemed inappropriate by Herndon, Ash, and Pollin (2014). Namely, Reinhart and K. S. Rogoff (2010) first assign each country year to one of the four categories, and then compute a country average for all the years it appeared in each category. These means are then averaged across countries, but their impact on the overall average is not weighted by the number of years each country appeared in the category. A country that appeared in the over-90% category for 19 years is weighted the same as a country that appeared only for one year. This seriously skews the main result of the paper.

Overall, Reinhart and Rogoff's result that the average growth rate for countries in the over-90% debt-to-GDP category is -0.1% is not robust to minor changes in the data. Herndon's, Ash's and Pollin's recalculation show the average growth rate in that category to be 2.2%, not significantly different from the average for the other three categories.

Both Reinhart and K. S. Rogoff (2010) and Herndon, Ash, and Pollin (2014) sprang a large literature on the relationship between debt and growth. C. D. Checherita-Westphal and Rother (2012) use a panel of 12 EU countries for the period of 1970 to 2008 to assess the existence of such a 90% threshold. Furthermore, they investigate the channels through which this threshold affects growth.

To test for the existence of a threshold, the authors use the following specification:

$$g_{it-j} = \alpha + \gamma_1 dsq_{it} + \gamma_2 d_{it} + \delta s_{it} + \phi p_{it} + x_{it} + \mu_i + v_t + \epsilon_{it}, \tag{37}$$

where g is the growth rate of real GDP, dsq is the squared gross government debt-to-GDP ratio, d is the debt-to-GDP ratio, s is the savings/investment rate, p is the population growth and x is a vector of control variables. μ_i, v_t are the country and time fixed effects and ϵ_{it} is the error term. When $j = 1$ is used, the short-term effects are assessed. Long-term effects are assessed by setting $j = 5$.

The authors find a highly significant non-linear relationship between debt and growth. The threshold is estimated to be around 90-100% of debt-to-GDP.

The proposed channels through which debt-to-GDP affects growth are: Private savings and investment, public investment, total factor productivity, and the real exchange rate. Private investment does not seem to account for the effect. Private saving and public investment on the other hand are more significant, and the threshold over which debt-to-GDP affects private saving (public investment) is 82-93% (47-70%). Total factor productivity is also affected by the debt-to-GDP, but this effect takes place after the 100% threshold.

Subsequent treatment of the matter, Baum, C. Checherita-Westphal, and Rother (2013) use a dynamic threshold panel estimation to answer much the same question, but also to identify the debt threshold econometrically. They use a panel of 12 euro area countries for

the period of 1990 to 2007 and use the following specification:

$$\begin{aligned} y_{it} = \mu_i + \chi y_{it-1} + \alpha_1 OPEN_{it-1} + a_2 GCF_{it-1} + a_3 EMU_{it} \\ + \beta_1 d_{it-1} I(d_{it-1} \leq d^*) + \beta_2 d_{it-1} I(d_{it-1} > d^*) + u_{it}, \end{aligned} \tag{38}$$

where y is the growth rate of real GDP, x is a set of regime independent control variables, $OPEN$ is a measure of trade openness, GCF is gross capital formation as a share of GDP, EMU is a dummy variable for the adoption of the euro, d is the debt-to-GDP ratio, d^* is the threshold, I is the indicator function and u is the error term. Aside from this benchmark specification, a dynamic threshold panel model is also estimated. The model is constructed by replacing y_{it-1} in 38 with the predicted values of the GDP growth rate, obtained by regressing y_{it-1} on its lags. The threshold value is selected after running a series of 2SLS regressions of the dynamic model and selecting the threshold value that minimizes the squared residuals.

In the non-dynamic model, the authors find that trade openness has a significant positive effect on growth, while gross capital formation has no significant effect. The adoption of the euro has a negative effect on growth. The debt-to-GDP ratio has a significantly positive effect on growth until the threshold is reached, and after that, no significant effect. In other words, the authors find no evidence that high debt-to-GDP ratios have a negative effect on growth, only that debt is expansionary when the debt-to-GDP ratio is low. Turning to the threshold value, it is estimated to be much lower, at 60% of debt-to-GDP.

The dynamic model yields similar results. The threshold is estimated to be 60% of debt-to-GDP, and the effect of debt on growth is positive until the threshold is reached, and insignificant afterwards. However, if one includes the years of the financial crisis, the model tells a different story: debt in excess of the threshold, which now stands at 95%, has a negative effect on growth.

To conclude, both C. D. Checherita-Westphal and Rother (2012) and Baum, C. Checherita-Westphal, and Rother (2013) find that debt-to-GDP ratios in excess of 90-95% have a negative effect on growth. However, this result is sensitive to changes in the data, the time frame and the exact specification utilized.

Kourtellos, Stengos, and Tan (2013) take a differenc approach and check instead if debt-to-GDP is a good threshold variable for growth. They use data for 82 countries for the periods of 1980-1989, 1990-1999 and 2000-2009. They use an augmented Solow growth moded, which incorporates debt-to-GDP:

$$g_i = \alpha_S' S_i + \alpha_d d_i + e_i, \tag{39}$$

where S is a set of Solow variables and d is the debt-to-GDP ratio. The model is further augmented by adding a threshold variable. The model is then

$$g_i = \beta' X_i + \delta' X_i I(d_i \leq \gamma) + \kappa \lambda_i(\gamma) + e_i, \tag{40}$$

where X is a set of control variables, I is the indicator function, γ is the threshold, λ is a scalar variable used to ensure that the errors have zero mean.

The authors test 15 different threshold variables, including debt-to-GDP, and find that debt-to-GDP is not a good threshold variable. The best threshold variable is the democracy measure. In other words, if one is to split the data into two regimes, the best way to do

so would be based on the quality of democracy. Eight other variables are also significant: Initial income, schooling, gross capital formation, population growth, the fertility rate, the life expectancy, inflation and a geographic dummy for tropical climate.

Debt-to-GDP ratio has a significant effect on growth, but only in countries with low quality of democracy. In other words, debt-to-GDP is not a good threshold variable, but it is a good predictor of growth in countries with low quality of democracy. In countries with high quality of democracy, debt-to-GDP has no significant effect on growth.

As opposed to the previous papers mentioned (C. D. Checherita-Westphal and Rother (2012), Baum, C. Checherita-Westphal, and Rother (2013)), Kourtellos, Stengos, and Tan (2013) do not investigate what the threshold value of the debt-to-GDP ratio is, but instead whether or not it is a good threshold variable. They find that it is not, and that the best threshold variable is the quality of democracy. Given that, they do find that higher debt leads to lower growth, but that only affects countries in the low-democracy regime. Note that both C. D. Checherita-Westphal and Rother (2012) and Baum, C. Checherita-Westphal, and Rother (2013) focus on EU countries, which generally have high democracy (they all belong to the high-democracy regime for all periods analized in Kourtellos, Stengos, and Tan (2013), which does not include post-Soviet states in their analysis).

In the same vein, Panizza and Andrea F. Presbitero (2014) incorporate the findings of Kourtellos, Stengos, and Tan (2013) that debt affects countries differently, based on those countries' characteristics. They also diagnose an issue of endogeneity: if debt is not exogenous, but rather debt is a function of growth, then the estimators are biased. To address this, they introduce an instrument for debt-to-GDP. That is the valuation effect on foreign currency-denominated public debt of changes in the exchange rate. Namely:

$$VE_{i,t} = \frac{\sum_{j=1}^{j=N} D_{ij,t}(e_{ij,t-1} - e_{ij,t})}{\sum_{j=1}^{j=N} D_{ij,t}}, \tag{41}$$

where VE is the valuation effect, D is the foreign currency-denominated public debt, e is the exchange rate and N is the number of foreign currencies in which the debt is denominated. The authors argue that this is a good instrument, because it is exogenous to the country's economic conditions, but it is correlated with the debt-to-GDP ratio.

Using a simple OLS regression of real per capita GDP, debt-to-GDP and other control variables on growth,

$$g_{it} = \alpha y_{it} + \beta d_i t + \gamma' X_{it} + \mu_i + \tau_i + e_{it}, \tag{42}$$

the authors find that debt-to-GDP has a negative effect on growth. However, when the instrument is used instead of the debt-to-GDP, the effect becomes insignificant and changes sign. This they present as evidence that the OLS estimator is biased.

To conclude, the authors find no evidence that debt-to-GDP has a negative effect on growth. What they find is that much of the literature on the subject is using negatively biased estimators to investigate the relationship between debt and growth.

Eberhardt and Andrea F. Presbitero (2015) approach the issue of debt and growth from a different angle. They see evidence of common factors across countries in the relationship between debt and growth, which leads to cross-section correlation and biased estimates. They also see evidence that there is significant heterogeneity across countries in the way debt and growth interact. Thus, they adopt a specification that can account both for the

common country effects and heterogeneity. Finally, they investigate the alleged non-linear relationship between growth and debt.

The authors use two specifications. The first is a linear dynamic model, which is given by

$$\begin{aligned} y_{it} &= \beta_i^K cap_{it} + \beta_i^D debt_{it} + u_{it}, \\ u_{it} &= \alpha_i + \lambda_{i'} \mathbf{f}_t + \epsilon_{it}, \end{aligned} \tag{43}$$

where y_{it} is aggregate GDP, cap_{it} is the capital stock, $debt_{it}$ is the debt stock. u_{it} is here to account for unobserved common factors. $\mathbf{f}$ is a set of said factors, and λ is a set of factor loadings.

The second specification is an asymetric dynamic model, which is given by

$$y_{it} = \alpha_i + \beta_i^K cap_{it} + \beta_i^D debt_{it}^+ + \beta^D debt_{it}^- + \lambda_{i'} \mathbf{f}_t + \epsilon_{it} \tag{44}$$

where $debt_{it}^+$ is the debt stock above the threshold, and $debt_{it}^-$ is the debt stock below the threshold.

The paper uses data for 118 countries for the period of 1960 to 2012. It is then the most comprehensive paper on the subject that has been presented here, thus far. Note that this dataset does not focus on a subset of countries, like C. D. Checherita-Westphal and Rother (2012) or Baum, C. Checherita-Westphal, and Rother (2013), but spans almost the entire globe.

The linear dynamic model is estimated using [1] Two-Way Fixed Effects, [2] Common Correlated Effects (CCE) (Pesaran (2006)), [3] Mean Group (MG), [4] Common Mean Group (CMG) estimators. The pooled parameter specifications (MG and CMG) estimates for debt are insignifficant. The heterogeneous parameters can shine light on the central tendencies of the panel data, and show a minimal non-linear relationship between d/GDP and growth, reversing to negative after about 90% d/GDP is reached. If one focuses on d/GDP peaks against growth, it is shown that this result is not very strong, since many countries have positive d/GDP coefs in excess of the thresshold of 90%. The non-linearity is driven by the top 25% richest countries in the dataset. The rest have a much weaker non-linear relationship. CMG estimates also show a non-linear relationship with a 90% threshold.

The asymetric dynamic model, on the other hand, shows no evidence that a systematic non-linear relationship exists, which can characterize the entire panel. Furthermore, shifting from the low-debt regime to the high-debt regime does not significantly change the debt coefficients.

To conclude, the authors find that the non-linear relationship between debt and growth is not uniform across countries. There is significant heterogeneity between countries in how debt affects growth, and the negative non-linear relationship seems to be a characteristic of more developed economies.

Egert (2015) uses formal econometric techniques to test the Reinhart and K. S. Rogoff (2010) hypothesis that debt-to-GDP ratios above 90% are associated with lower growth. The author constructs a four-regime model, with debt thresholds of 30%, 60% and 90%, as in Reinhart and K. S. Rogoff (2010). He then uses grid search to find a threshold value, T, that minimizes the sum of squared residuals for a two-regime model, and furthermore finds two more threshold values, T_1, T_2, which are the upper and lower bound of a three-regime

model, by holding T constant and locating T_1, T_2 such that each regime contains at least 2% of the observations and the sums of residuals squared are minimized. The threshold models estimated are then:

Four-regime model:

$$\Delta y_t = \begin{cases} \alpha_1 + \beta_1 d_{t-1} + \epsilon_t & \text{if } d_{t-1} < 30\% \\ \alpha_2 + \beta_2 d_{t-1} + \epsilon_t & \text{if } 30\% \leq d_{t-1} < 60\% \\ \alpha_3 + \beta_3 d_{t-1} + \epsilon_t & \text{if } 60\% \leq d_{t-1} < 90\% \\ \alpha_4 + \beta_4 d_{t-1} + \epsilon_t & \text{if } d_{t-1} \geq 90\% \end{cases} \tag{45}$$

Three-regime model:

$$\Delta y_t = \begin{cases} \alpha_1 + \beta_1 d_{t-1} + \epsilon_t & \text{if } d_{t-1} < T_1 \\ \alpha_2 + \beta_2 d_{t-1} + \epsilon_t & \text{if } T_1 \leq d_{t-1} < T_2 \\ \alpha_3 + \beta_3 d_{t-1} + \epsilon_t & \text{if } d_{t-1} \geq T_2 \end{cases} \tag{46}$$

Two-regime model:

$$\Delta y_t = \begin{cases} \alpha_1 + \beta_1 d_{t-1} + \epsilon_t & \text{if } d_{t-1} < T \\ \alpha_2 + \beta_2 d_{t-1} + \epsilon_t & \text{if } d_{t-1} \geq T \end{cases} \tag{47}$$

where y is the growth rate of real GDP, d is the debt-to-GDP ratio and ϵ is the error term. Note that the author uses lagged values of debt-to-GDP, as is common practice in the literature, to combat endogeneity issues that exist in the relationship between GDP and debt-to-GDP. Common country effects are included as well.

The author uses data for 41 countries for the period of 1946 to 2009. The dataset can be segmented into two groups: 20 developed countries and 21 emerging countries. This includes the 16 emerging countries that were included in the original Reinhart and K. S. Rogoff (2010) study, plus 5 (China, Egypt, Korea, Russia, Taiwan).

Initially, the regressions use the arbitrary thresholds of $T = 90\%$, $T_1 = 30\%$ and $T_2 = 60\%$. Later, these threshold values are computed as described above. The canonical four-regime model (*á la* Reinhart and K. S. Rogoff (2010)) produces significant and negative correlations of debt and growth starting from the >30% regime, but this effect is only present in developed countries. Developing countries on the other hand see weakly positive (in the original 16 countries) or weakly negative (when China, Egypt, Korea, Russia and Taiwan are included) effects on growth.

The three-regime model produces a negative effect that is still only present in developed countries, and a weakly significant positive effect is detected for the dataset of 16 developing countries after the T_2 threshold. Similarly, the two-regime model produces a very small but statistically significant negative effect on growth, which is only present in developed countries.

When allowing for endogenous selection of threshold values, the results change. For the two-regime model, the threshold value for all countries is 16.5%, but for developed countries alone it is 20%, and for developing, 36-38%. There does exist a negative non-linear relationship which sets off after this threshold, but it is only significant for developed countries (which in turn makes it significant when the entire dataset is considered, but it

is insignificant for developing countries). For the three-regime model, the null hypothesis of a linear relationship cannot be rejected, further weakening the evidence of a systematic negative, non-linear relationship between debt and growth.

Overall, Egert (2015) show evidence that the hypothesised negative non-linear relationship of debt and growth, with a threshold of 90% debt-to-GDP is fairly weak. If anything, it is only present in developed countries, and the threshold value after which a significant change in the growth rate sets in is much lower than 90%. This largely confirms the findings of Herndon, Ash, and Pollin (2014), Panizza and Andrea F. Presbitero (2014) and Eberhardt and Andrea F. Presbitero (2015).

The endogeneity issue is handled differently in Constance, Reina, and Mengxue (2022), where the authors first identify exogenous shocks to public debt-to-GDP ratios by using forecast errors. Specifically, the debt shocks are given by

$$\begin{aligned} debt_{it}^{shock} &= \Delta \ln debt_{it} - \Delta \ln debt_{it}^{f}, \\ \Delta debt_{it} &= \ln debt_{it}/GNP_{it} - \ln debt_{it-1}/GNP_{it-1}, \\ \Delta debt_{it}^{f} &= \ln debt_{it}^{f}/GNP_{it} - \ln debt_{it-1}^{f}/GNP_{it-1}, \end{aligned} \tag{48}$$

where *debt* is the public debt, GNP is gross national product and f denotes forecast. The forecast errors are obtained from the IMF's World Economic Outlook (WEO) database. The authors then use these shocks as instruments for the debt-to-GDP ratio in a panel regression of growth on debt-to-GDP. The model is

$$y_{it+k} - y_{it-1} = c_i^k + d_t^k + \beta^k debt_{it}^{shock} + \theta^k Z_{it} + \epsilon_{it}, \tag{49}$$

where y is the level of real GDP, c is a country fixed effect, d is a time fixed effect, $debt^{shock}$ is the identified debt-to-GDP exogenous shock, Z is a set of control variables and ϵ is the error term. k is set from 0 to 5 to investigate short- and long-term effects of debt shocks.

Using data from 1995 to 2022 for all countries in the IMF's WEO database, the authors find the following results:

An unexpected increase in the public debt of 1% decreases GDP by 0.01% three years after the shock. The effect is stronger, the higher the debt-to-GDP ratio of the country, and stronger still if the debt-to-GDP ratio is in an upwards trajectory. Specifically, by splitting the dataset into high- and low-debt regimes (the threshold being the dataset median of 46%), low-debt countries on average do not experience significant effects on growth, but high-debt countries experience a 0.02% decrease in GDP levels. Similarly, by splitting the dataset into rising and declining debt-to-GDP trajectory countries, those in the declining debt trajectory subset do not experience any significant effects on growth, but those in the rising debt trajectory subset experience a 0.03% decline.

The paper further investigates the heterogeneous effects of debt shocks on growth, by splitting the dataset into high-, middle- and low-income countries, based on the World Bank classification. Similar to the already mentioned literature, the negative effects of debt are only present in high-income countries. For low-income countries, debt shocks even have a positive effect on growth.

Heimberger (2023) conducts a meta-analysis of the empirical literature, including 816 estimates from 47 studies. The linear relationship between debt and growth is investigated in

31 studies, where the debt-to-GDP is included as an independent variable in the specification. The 556 Standardized Coefficients have a mean of -0.01, indicating a negative relationship. This relationship is not very strong, however, since alternative estimations yield results that are much closer to 0. The author suspects publication bias, which is tested for by the following model:

$$SC_{ij} = \beta_0 + \beta_1 SE_{ij} + \epsilon_{it}, \tag{50}$$

where SC is the standardized coefficient, SE is the standard error and ϵ is the error term. The null hypothesis of $\beta_1 = 0$ is rejected, pointing to publication bias in favor of results of negative coefficients. If this large publication bias is controlled for, then the effect of debt on growth is negligent.

Turning to threshold effects, the author uses 260 estimates from 22 studies. The median of the estimates is 53.5%, and the weighted average is 64.2%. However, there are signs of heterogeneity in this effect The meta-regression equation used to investigate this heterogeneity is

$$TE_{ij} = \beta_0 + \beta_1 SE_{ij} + \beta_x X_{ij} + \epsilon_{it}, \tag{51}$$

where TE is the threshold estimate, SE is the standard error, X is a set of control variables and ϵ is the error term. By breaking down the sample into advanced and developing economies, it is clear that the threshold for the latter is much lower than for the former: 23% lower threshold values for developing countries. The 90% threshold is reached much easier in the literature, if the specification includes a quadratic term for debt, which indicates that the result is sensitive to specification choice. Overall, the paper concludes that there is significant heterogeneity when it comes to threshold effects, which are drastically different for advanced versus developing economies. The canonical 90% threshold is not robust to changes in specification.

5 Conclusion

The literature on sovereign debt crises is vast and varied. The theoretical models surveyed in this paper offer a good overview of the different approaches to the analysis of sovereign debt crises and showcase the significant advances that took place in the last 40 years. Considering the seminal work of Eaton and Gersovitz (1981) as a starting point, which is fairly simplistic in its assumptions about income and the cost of default, the most recent literature has evolved to encompass such factors as business cycle fluctuations, general equilibrium modelling, the maturity structure of debt and restructuring dynamics. The empirical literature has gone through a similar transformation, employing advanced econometric techniques to investigate the relationship between debt and default.

In this thesis, I have attempted to provide a comprehensive overview of the literature on sovereign debt and default. I have discussed the various research interests that motivated each study, the methods used and the results reached. The theoretical literature is deeply interesting, especially at times of economic uncertainty. The empirical studies discussed vary in their results, and a clear consensus has not been reached as of yet. The main advances in our understanding of the relationship between debt and growth come from the evidence of heterogeneity in the relationship: more and more, the literature focuses on this fact, and

the most recent evidence for the existence of this heterogeneity come from the exhaustive meta-analysis of Heimberger (2023). Another major point of interest is the existence of a threshold value for debt, after which a negative relationship exists between debt and growth. To this, the literature surveyed cannot answer categorically. The negative relationship, as shown by Heimberger (2023), and as already alluded by Herndon, Ash, and Pollin (2014) is negligent in aggregate: it is however more pronounced for advanced economies than for emerging ones.

This thesis is aimed as a primer for those interested in the matter of sovereign debt, default, and the relationship between debt and growth. It is by no means exhaustive, and the literature is constantly evolving. The recent COVID-19 pandemic has brought the issue of sovereign debt to the forefront of economic policy, and the literature is sure to grow in the coming years.

References

Aguiar, Mark, Satyajit Chatterjee, et al. (2022). "Self-fulfilling debt crises, revisited". In: *Journal of Political Economy* 130.5, pp. 1147–1183.

Aguiar, Mark and Gita Gopinath (June 2006). "Defaultable debt, interest rates and the current account". In: *Journal of International Economics* 69.1, pp. 64–83. URL: https://ideas.repec.org/a/eee/inecon/v69y2006i1p64-83.html.

Amemiya, Takeshi (Sept. 1978). "The Estimation of a Simultaneous Equation Generalized Probit Model". In: *Econometrica* 46.5. Dynamics, Economic Growth and International Trade, pp. 1193–1205.

Ardagna, Silvia (2004). "Fiscal stabilizations: When do they work and why". In: *European economic review* 48.5, pp. 1047–1074. URL: url=%7Bhttps://www.sciencedirect.com/science/article/pii/S0014292103001235%7D.

Arellano, Cristina (June 2008). "Default Risk and Income Fluctuations in Emerging Economies". In: *American Economic Review* 98.3, pp. 690–712. DOI: 10.1257/aer.98.3.690. URL: https://www.aeaweb.org/articles?id=10.1257/aer.98.3.690.

Arellano, Cristina and Ananth Ramanarayanan (2012). "Default and the Maturity Structure in Sovereign Bonds". In: *Journal of Political Economy* 120.2, pp. 187–232. ISSN: 00223808, 1537534X. (Visited on 01/15/2023).

Baum, Anja, Cristina Checherita-Westphal, and Philipp Rother (Oct. 2013). "Debt and growth: new evidence for the euro area". In: *Journal of International Money and Finance* 32, pp. 809–821. ISSN: 0261-5606.

Bi, Huixin (2012). "Sovereign default risk premia, fiscal limits, and fiscal policy". In: *European Economic Review* 56.3, pp. 389–410. ISSN: 0014-2921. DOI: https://doi.org/10.1016/j.euroecorev.2011.11.001. URL: https://www.sciencedirect.com/science/article/pii/S0014292111001085.

Bulow, Jeremy and Kenneth Rogoff (Mar. 1989). "Sovereign Debt: Is to Forgive to Forget?" In: *American Economic Review* 79.1, pp. 43–50.

Checherita-Westphal, Cristina D. and Philipp Rother (Oct. 2012). "The impact of high government debt on economic growth and its channels: An empirical investigation for the euro area". In: *European Economic Review* 56.7, pp. 1392–1405. ISSN: 0014-2921.

Chowdhury, Khorshed (1994). "A structural analysis of external debt and economic growth: some evidence from selected countries in Asia and the Pacific". In: *Applied Economics* 26.12, pp. 1121–1131.

Cole, Harold L. and Timothy J. Kehoe (Jan. 2000). "Self-Fulfilling Debt Crises". In: *The Review of Economic Studies* 67.1, pp. 91–116. ISSN: 0034-6527. DOI: 10.1111/1467-937X.00123. eprint: https://academic.oup.com/restud/article-pdf/67/1/91/4481288/67-1-91.pdf. URL: https://doi.org/10.1111/1467-937X.00123.

Constance, de Soyres, Kawai Reina, and Wang Mengxue (Apr. 2022). *Public Debt and Real GDP: Revisiting the Impact*. Working Paper WP/22/76. International Monetary Fund.

Cuadra, Gabriel and Horacio Sapriza (2008). "Sovereign default, interest rates and political uncertainty in emerging markets". In: *Journal of International Economics* 76.1, pp. 78–88. ISSN: 0022-1996. DOI: https://doi.org/10.1016/j.jinteco.2008.05.001. URL: https://www.sciencedirect.com/science/article/pii/S0022199608000445.

D'Erasmo, Pablo and Enrique G. Mendoza (2016). "Distributional incentives in an equilibrium model of domestic sovereign default". In: *Journal of the European Economic Association* 14.1, pp. 7–44. DOI: https://doi.org/10.1111/jeea.12168. eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1111/jeea.12168. URL: https://onlinelibrary.wiley.com/doi/abs/10.1111/jeea.12168.

D'Erasmo, Pablo and Enrique G. Mendoza (2021). "History remembered: Optimal sovereign default on domestic and external debt". In: *Journal of Monetary Economics* 117, pp. 969–989. ISSN: 0304-3932. DOI: https://doi.org/10.1016/j.jmoneco.2020.07.006. URL: https://www.sciencedirect.com/science/article/pii/S030439322030088X.

De Haan, Jakob and Jan-Egbert Sturm (1994). "Political and institutional determinants of fiscal policy in the European Community". In: *Public choice* 80.1-2, pp. 157–172.

Eaton, Jonathan and Mark Gersovitz (1981). "Debt with potential repudiation: Theoretical and empirical analysis". In: *The Review of Economic Studies* 48.2, pp. 289–309.

Eberhardt, Markus and Andrea F. Presbitero (2015). "Public debt and growth: Heterogeneity and non-linearity". In: *Journal of International Economics* 97.1, pp. 45–58. ISSN: 0022-1996. DOI: https://doi.org/10.1016/j.jinteco.2015.04.005. URL: https://www.sciencedirect.com/science/article/pii/S0022199615000690.

Egert, Balazs (2015). "Public debt, economic growth and nonlinear effects: Myth or reality?" In: *Journal of Macroeconomics* 43, pp. 226–238. ISSN: 0164-0704. DOI: https://doi.org/10.1016/j.jmacro.2014.11.006. URL: https://www.sciencedirect.com/science/article/pii/S0164070414001335.

Fink, Fabian and Almuth Scholl (2016). "A quantitative model of sovereign debt, bailouts and conditionality". In: *Journal of International Economics* 98, pp. 176–190. ISSN: 0022-1996. DOI: https://doi.org/10.1016/j.jinteco.2015.09.007. URL: https://www.sciencedirect.com/science/article/pii/S0022199615001464.

Galli, Carlo (2021). "Self-fulfilling debt crises, fiscal policy and investment". In: *Journal of International Economics* 131, p. 103475.

Ghosh, Atish R. et al. (2013). "Fiscal Fatigue, Fiscal Space and Debt Sustainability in Advanced Economies". In: *The Economic Journal* 123.566, F4–F30. DOI: https://doi.org/10.1111/ecoj.12010. eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1111/ecoj.12010. URL: https://onlinelibrary.wiley.com/doi/abs/10.1111/ecoj.12010.

Hagen, Jurgen von (Oct. 1992). "Budgeting Procedures and Fiscal Performance in the European Communities". In: *Economic Papers* 96.

Hatchondo, Juan Carlos and Leonardo Martinez (2009). "Long-duration bonds and sovereign defaults". In: *Journal of International Economics* 79.1, pp. 117–125. ISSN: 0022-1996. DOI: https://doi.org/10.1016/j.jinteco.2009.07.002. URL: https://www.sciencedirect.com/science/article/pii/S0022199609000907.

Heimberger, Philipp (2023). "Do higher public debt levels reduce economic growth?" In: *Journal of Economic Surveys* 37.4, pp. 1061–1089. DOI: https://doi.org/10.1111/joes.12536. eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1111/joes.12536. URL: https://onlinelibrary.wiley.com/doi/abs/10.1111/joes.12536.

Herndon, Thomas, Michael Ash, and Robert Pollin (2014). "Does high public debt consistently stifle economic growth? A critique of Reinhart and Rogoff". In: *Cambridge journal of economics* 38.2, pp. 257–279.

Kletzer, Kenneth M. (1984). "Asymmetries of Information and LDC Borrowing with Sovereign Risk". In: *The Economic Journal* 94.374, pp. 287–307. ISSN: 00130133, 14680297. URL: http://www.jstor.org/stable/2232351 (visited on 09/12/2023).

Kourtellos, Andros, Thanasis Stengos, and Chih Ming Tan (2013). "The effect of public debt on growth in multiple regimes". In: *Journal of Macroeconomics* 38. Dynamics, Economic Growth and International Trade, pp. 35–43. ISSN: 0164-0704. DOI: https://doi.org/10.1016/j.jmacro.2013.08.023. URL: https://www.sciencedirect.com/science/article/pii/S0164070413001456.

Lizarazo, Sandra Valentina (2013). "Default risk and risk averse international investors". In: *Journal of International Economics* 89.2, pp. 317–330. ISSN: 0022-1996. DOI: https://doi.org/10.1016/j.jinteco.2012.08.006. URL: https://www.sciencedirect.com/science/article/pii/S0022199612001511.

Mendoza, Enrique G. and Vivian Z. Yue (2012). "A GENERAL EQUILIBRIUM MODEL OF SOVEREIGN DEFAULT AND BUSINESS CYCLES". In: *The Quarterly Journal of Economics* 127.2, pp. 889–946. ISSN: 00335533, 15314650. (Visited on 01/15/2023).

Panizza, Ugo and Andrea F Presbitero (2013). "Public debt and economic growth in advanced economies: A survey". In: *Swiss Journal of Economics and Statistics* 149, pp. 175–204.

— (2014). "Public debt and economic growth: Is there a causal effect?" In: *Journal of Macroeconomics* 41, pp. 21–41. ISSN: 0164-0704. DOI: https://doi.org/10.1016/j.jmacro.2014.03.009. URL: https://www.sciencedirect.com/science/article/pii/S0164070414000536.

Pasinetti, Luigi L. (Jan. 1998). "The myth (or folly) of the 3% deficit/GDP Maastricht 'parameter'". In: *Cambridge Journal of Economics* 22.1, pp. 103–116.

Pesaran, M. Hashem (2006). "Estimation and Inference in Large Heterogeneous Panels with a Multifactor Error Structure". In: *Econometrica* 74.4, pp. 967–1012. DOI: https://doi.org/10.1111/j.1468-0262.2006.00692.x. eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1468-0262.2006.00692.x. URL: https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1468-0262.2006.00692.x.

Reinhart, Carmen M. and Kenneth S. Rogoff (May 2010). "Growth in a Time of Debt". In: *American Economic Review* 100.2, pp. 573–78. DOI: 10.1257/aer.100.2.573. URL: https://www.aeaweb.org/articles?id=10.1257/aer.100.2.573.

Stähler, Nikolai (2013). "RECENT DEVELOPMENTS IN QUANTITATIVE MODELS OF SOVEREIGN DEFAULT". In: *Journal of Economic Surveys* 27.4, pp. 605–633. DOI: https://doi.org/10.1111/j.1467-6419.2012.00741.x. eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1467-6419.2012.00741.x. URL: https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1467-6419.2012.00741.x.

Yamin, Ismail et al. (Mar. 2023). "The Influence of Public Debt on Economic Growth: a Review of Literature". In: *International Journal of Professional Business Review* 8, e01772. DOI: 10.26668/businessreview/2023.v8i4.1772.