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Juan Carlos Conesa
Stony Brook University

Timothy J. Kehoe
University of Minnesota, Federal Reserve Bank of Minneapolis, and NBER

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Juan Carlos Conesa
Stony Brook University

Timothy J. Kehoe
University of Minnesota,
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ABSTRACT

By *preemptive austerity*, we mean a policy that increases taxes to deter potential rollover crises. The policy is so successful that the usual danger signal of a rollover crisis, a high yield on new bonds sold, does not show up, because the policy eliminates the danger. Mechanically, high taxes make the safe zone in the model — the set of sovereign debt levels for which the government prefers to repay its debt rather than default — larger. By announcing a high tax rate at the beginning of the period, the government ensures that tax revenue will be high enough to service sovereign debt becoming due, which deters panics by international lenders but is ex-post suboptimal. That is why, as it engages in preemptive austerity, the government continues to reduce the level of debt to a point where, at least asymptotically, high taxes are no longer necessary.

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1 Introduction

This paper provides a novel rationale for fiscal austerity when countries face rollover risk. By choosing a high tax rate in advance, the sovereign can preempt the possibility of a panic becoming self-fulfilling, guaranteeing access to credit at a low interest rate. We refer to this rationale as *preemptive austerity*, and we show that it can arise even during a severe recession that would otherwise call for counter-cyclical fiscal policy to smooth consumption. Our analysis shows that austerity can be optimal even when there is access to cheap credit. In fact, the logic can be the reverse: it is precisely because of costly austerity that access to cheap credit is possible in the first place.

To determine under what values of economic fundamentals preemptive austerity can be the optimal fiscal policy, we extend the model of Cole and Kehoe (1996, 2000) and Conesa and Kehoe (2017) to allow taxes to be endogenously chosen by the government. In an environment where tax rates are pre-announced and fixed during one period (corresponding to one year), setting a high tax rate in advance can prevent lender panics from becoming self-fulfilling, thus guaranteeing continued access to cheap sovereign credit. As a result, the sovereign chooses to respond to a recession by increasing taxes and lowering government expenditures, instead of borrowing against future income.

When the 2008–12 recession hit Europe, different countries reacted differently. Some countries reacted by increasing debt even when faced with a spike in interest rates, and Conesa and Kehoe (2017) analyzed the incentives to engage in this form of *gambling for redemption* in a recession to smooth government consumption in the face of declining tax revenues. In the model of rollover crises of Cole and Kehoe (1996, 2000) and Conesa and Kehoe (2017), when the country is not in a recession, a country that is vulnerable to a rollover crisis can borrow at the risk free interest rate, and it is optimal to do so. Why would countries like Germany choose to run fiscal surpluses right after entering a recession? This seemingly suboptimal behavior is inconsistent with the standard model and was the source of criticism in political, and even academic, circles. For example, Tooze (2012) wrote,

> The financial conditions for such spending have never been more favorable: interest rates for public borrowing are approaching zero. And yet due to a 2009 constitutional amendment requiring both the federal and the state governments to maintain balanced budgets, the German public sector has denied itself the opportunity to borrow and invest.

Our exercise shows that the logic goes the other way around: it is precisely because of fiscal austerity that interest rates stay low. The optimality of preemptive austerity for certain values of the economic fundamentals hinges crucially on the timing of decisions in

our model. If the tax rate were chosen at the end of the period, after the sunspot that signals international lenders to panic or not has been revealed, the optimal behavior would be standard: inside the safe zone, countries have access to credit at the risk free rate and should borrow in bad times to smooth consumption. Such a timing would imply that the tax rate can be determined after production has taken place, generating substantial distortions in production decisions (in our model, labor supply decisions). In the United States, for example, the income tax schedule for 2023 was announced in November of 2022, and will be applied to all income generated during the year once it is over (in April of 2024). While this type of commitment is natural in many countries, others might lack the credibility necessary for it. Their situation opens a window for institutions such as the European Stability Mechanism, or the IMF in a broader context.

By committing to high taxes at the beginning of the period, a government ensures itself high tax revenue, which then makes the government prefer to repay the amount of debt becoming due, on which it would otherwise default. After the government is able to auction off new debt at a high price, however, this high level of tax revenue is ex-post suboptimal. The high taxes distort the labor-leisure trade-off, making output smaller than it would have been. High taxes also make government spending suboptimally high compared with private consumption. The possibility of preemptive austerity benefits an economy, compared with setting taxes at a constant level forever. A commitment to a state-contingent policy of increasing taxes only at the onset of a financial crisis would be even better, and it would never be used in equilibrium, but it seems difficult, if not impossible to implement. In terms of our model, a substitute would be an insurance program that would provide the government with funds to avoid a default, but such a program would be fraught with moral hazard problems.

Our analysis includes a discussion of the different strategies that could have been optimal for different European countries during the 2008-12 recession, depending on their initial level of debt before 2008 and the severity and duration of the recession. These countries became vulnerable to lenders' panics generating the sudden spikes in interest rates that occurred in southern European countries during the debt crisis of 2010–12, which triggered the famous "whatever it takes" intervention of Mario Draghi at the European Central Bank. For example, Spain started with debt at 36 percent of GDP before the summer of 2008, and that implies it had room to lower taxes and run up debt to smooth consumption. Unfortunately, by the end of 2010, debt was higher than 60 percent of GDP, and preemptive austerity would have been optimal. In contrast, Germany entered a less severe recession (and a faster recovery) with debt at 80 percent of GDP, but immediately engaged in preemptive austerity.

There is a vast literature addressing debt crises as a result of the absence of commitment

to repay debts and the inability to write down contingent contracts. See Aguiar and Amador (2014) for a review of the fundamental issues in this literature, and also Aguiar and Amador (2021). Within that framework two kinds of debt crisis are possible. First, in a *solvency crisis*, countries can default because the fundamentals of their economy worsen beyond the point where servicing the debt is better than declaring a default. A large strand of the literature focuses on this type of crisis, following the pioneering contributions of Eaton and Gersovitz (1981), Hamann (2002), Aguiar and Gopinath (2007) and Arellano (2008). Second, in a *liquidity crisis*, a solvent country can default because its inability to roll over its existing debt makes it impossible to service the debt. This opens the possibility of self-fulfilling debt crises, in the spirit of Cole and Kehoe (1996, 2000).

While in our model, both types of debt crises are possible, we focus our discussion on liquidity crises since the simplifying assumptions that we make render the model less suitable to addressing solvency crises. Roch and Uhlig (2018) develop a model in which both types of crises are possible, and they discuss the role of potential bailouts. Conesa and Kehoe (2014) also discuss the role of bailouts, using the much simpler framework proposed in Conesa and Kehoe (2017). Neimann and Pichler (2020) analyze optimal fiscal policy in a business cycle environment that also allows for both types of crises and endogenizes the tax-expenditure policy. Crucially, in their model taxes are chosen after borrowing has taken place, while we focus on the strategic decision of choosing taxes in advance of credit markets opening, which provides incentives for the preemptive austerity behavior that constitutes the main point in this paper.

2 Benchmark model

We introduce two critical departures from Conesa and Kehoe (2017). First, we endogenize the tax rate, which is constant in Conesa and Kehoe (2017). Second, we introduce a labor supply decision that, together with productivity (which is stochastic), determines output. With our parameterization, an increase in tax rates discourages labor supply and further depresses output. Thus, increasing taxes not only is painful because of its direct impact on disposable income but also is costly in terms of aggregate production, even more so during a recession.

2.1 Technology and production

Output y is linear in labor supplied by the household, ℓ:

$$y(a, z) = \theta(a, z)\ell,$$

where aggregate productivity is $\theta(a, z) = A^{1-a}Z^{1-z}\bar{\theta}$, with $A < 1$ and $Z < 1$. Productivity depends on the business cycle and the default history of the government. In *normal times* $a = 1$, while in a *recession,* $a = 0$, and productivity is reduced by the factor $1 - A$. Similarly, $z = 1$ indicates that the government has not defaulted in the past, and a default, $z = 0$, implies that productivity immediately and forever falls by the factor $1 - Z$.

Before period 0, the economy is in normal times, and the government has never defaulted; that is, $a = 1$ and $z = 1$. Then, in period 0, the economy unexpectedly enters a recession, and productivity falls. In every period thereafter, there is a Poisson probability $p \in (0, 1)$ of an economic recovery. For simplicity we assume that once the economy recovers, $a = 1$ forever.

2.2 Households

There is a continuum of measure one of identical households with the utility function

$$u(c, \ell, g) = (1/\rho)\log[\mu c^{\rho} + (1 - \mu)(1 - \ell)^{\rho}] + \gamma \log(g - \bar{g}). \tag{1}$$

Preferences depend on private consumption c and leisure $1 - \ell$ in a CES aggregator, and on government expenditure g, which enters separately in the utility function. Following Conesa and Kehoe (2017), we assume a non-homotheticity in the utility of government consumption that takes the form of a minimum level of government consumption $\bar{g}$. This can be interpreted as the level of government expenditure that is politically difficult to cut — for example, entitlement spending in the United States.

The parameter ρ governs the labor supply elasticity. A value of $\rho \in (0, 1)$ guarantees that an increase in taxes will have a negative impact on hours worked.

We do not allow private borrowing or lending, so the household problem is static and simply says that private consumption c is equal to after-tax income (equal to output), where τ denotes the tax rate:

$$c = (1 - \tau)\theta(a, z)\ell$$

.

The solution to the households' problem depends only on productivity and on the tax

rate, generating a policy function, $\ell(a, z, \tau)$, that the government takes as given.

2.3 Government

The government finances government expenditure and the debt service to international lenders by raising taxes and issuing new debt that is sold in a public auction.

As in any other model of rollover crises, the maturity of debt plays a key role, since it determines how often governments need to refinance their existing debts. Following Hatchondo and Martinez (2009) and Chatterjee and Eyigungor (2012), we assume that a fraction δ of the existing stock of debt comes due in each period. It is worth pointing out that, in contrast to Bianchi et al. (2018) and Bianchi and Sosa-Padilla (2023), where multi-period debt is necessary for reserve accumulation to be optimal, the optimality of preemptive austerity does not depend on multi-period debt. Instead, we choose multi-period debt because it provides numerical results more aligned with the levels of debt observed in European countries.

The government's budget constraint is

$$g + z\delta B = \tau\theta(a, z)\ell(a, z, \tau) + q(B', s)(B' - (1 - \delta)B),$$

where $q(B', s)$ is the price schedule for new debt, and z takes a value of 1 if the government services the debt and 0 if the government defaults on debt payments. This price schedule depends on the state of the economy $s = (a, z_{-1}, B, \zeta)$. If $z_{-1} = 0$, then $q = 0$; that is, if the government has defaulted in the past, then it is excluded from lending markets permanently. Otherwise, the price depends on the probability that the government repays next period.

2.4 International Lenders

There is a continuum of measure one of international lenders. Following Cole and Kehoe (1996, 2000), we use an exogenous sunspot variable, ζ, as the coordination mechanism among international lenders. This sunspot variable is uniformly and independently distributed on the interval $[0, 1]$. If $\zeta > 1 - \pi$, where π is an exogenous number, each individual lender expects that other lenders will not show up at the public auction for new debt. Since each lender has measure zero, the lenders evaluate whether a failed auction would trigger a default or not. If the answer is yes, then the lenders optimally choose to not show up at the auction, and a default will occur. In contrast, if they understand that the government will have no incentive to default even if the auction fails, then the lenders rationally choose to attend the auction and purchase any level of debt the government chooses given the competitive price schedule. In other words, panics are self-fulfilling for certain values of economic fundamentals

and otherwise are inconsequential.

To simplify the pricing of debt, we assume that lenders are risk-neutral and have *deep pockets*. That implies that lenders are never individually constrained and can lend as much as the government offers at auction, and the pricing is actuarially fair; that is, lenders break even on expectation. Under these assumptions, the unit price of bonds is

$$q(B', s) = \beta \times E\{z(B'(s'), s')[\delta + (1-\delta)q'(B'(s'), s')]\}. \tag{2}$$

In a world with $\delta = 1$ (one period bonds), the price is equal to the discount factor times the probability of repayment next period. If there is no risk of default — that is, $Ez(B'(s'), s') = 1$ — the interest rate would be the risk free rate $1/\beta - 1$. For longer duration of bonds $\delta < 1$, the term $[\delta + (1-\delta)q'(B'(s'), s')]$ corrects the price for the duration of the bond.

2.5 Timing of decisions

Within a period, the sequence of events is as follows:

1. The government chooses the tax rate, given the state of the economy, the stock of debt outstanding, and its history of default (a, B, z_{-1}).
2. The random variable ζ is realized, and the government chooses B'.
3. The bond auction takes places.
4. The government chooses to default or not, households decide how much to work, and production takes place.

Crucially, the government does not know the value of the sunspot at the time of choosing the tax rate. This timing implicitly assumes that taxes are announced at the beginning of the year and that investors' panics can unfold at any moment during the year when the government needs to access credit to service maturing debt.

3 Characterization of the equilibrium prices

As in Conesa and Kehoe (2017), the equilibrium can be characterized by debt thresholds that separate the *safe zone* (debt is low enough that the country can borrow at the risk free rate) from the *crisis zone* (debt is large enough that a rollover crises is possible if the sunspot realization indicates lenders panic). No borrowing is possible above the crisis zone, since that would imply immediate default. These thresholds depend on the state of the economy, and the lower threshold in a recession is below that in normal times — that is, $\bar{b}(0) < \bar{b}(1)$ — and the same is true for the upper thresholds, $\bar{B}(0) < \bar{B}(1)$. The crucial difference is that in this model, the choice of the tax rate affects these thresholds.

We report prices for the case that $\bar{b}(0) < \bar{b}(1) < \bar{B}(0) < \bar{B}(1)$, since this is the relevant case in our computational exercise. (For a severe enough recession, it is possible that $\bar{B}(0) < \bar{b}(1)$.) Also notice that, those prices depend only on the debt issued, conditional on no default history and no panics today. Otherwise, if the government defaulted in the past or if there is a panic in the crisis zone this year, then the price of debt is zero.

The prices in normal times satisfy

$$q(B', (B, 1, 1, \zeta)) = \begin{cases} \beta(\delta + (1-\delta)q'(\cdot)) & \text{if } B' \leq \bar{b}(1) \\ \beta(1-\pi)(\delta + (1-\delta)q'(\cdot)) & \text{if } \bar{b}(1) < B' \leq \overline{B}(1) \\ 0 & \text{if } B' > \overline{B}(1). \end{cases}$$

Remember that a fraction δ of bonds issued this year pay one unit of the consumption good next year, and a fraction $(1-\delta)$ do not mature and have a value of $q'(\cdot)$ next year. That explains the term that multiplies the discount factor in the safe zone. In the crisis zone, the bond has positive value only if there is no panic, and that happens with probability $(1-\pi)$.

In a recession the pricing is more complex and is affected by the probability of an economic recovery:

$$q(B', (B, 0, 1, \zeta)) = \begin{cases} \beta(\delta + (1-\delta)q(\cdot)) & \text{if } B' \leq \bar{b}(0) \\ \beta(p + (1-p)(1-\pi))(\delta + (1-\delta)q'(\cdot)) & \text{if } \bar{b}(0) < B' \leq \bar{b}(1) \\ \beta(1-\pi)(\delta + (1-\delta)q'(\cdot)) & \text{if } \bar{b}(1) < B' \leq \bar{B}(0) \\ \beta p(1-\pi)(\delta + (1-\delta)q'(\cdot)) & \text{if } \bar{B}(0) < B' \leq \bar{B}(1) \\ 0 & \text{if } B' > \bar{B}(1). \end{cases}$$

Here, prices need a bit more explanation. In the zone between the lower threshold in bad times and in good times, the government repays if the economy recovers, and that happens with probability p. If the economy does not recover but there is no panic the government likewise repays, and that happens with probability $(1-p)(1-\pi)$. For levels of debt in the crisis zone, regardless of the state of the economy, the price is adjusted by the probability of a panic. Finally, there is another area between the upper threshold in recessions and normal times. In this area, the government repays tomorrow only if the economy recovers and there is no panic, and that happens with probability $p(1-\pi)$.

Table 1: Parameters

	Value	Target/assumption
A	0.95	productivity loss in recession = 5%
Z	0.95	default penalty
p	0.20	expected recovery = 5 years
β	0.98	safe bond yield = 2% (annual)
π	0.03	real interest rate in crisis zone = 5% (annual)
δ	1/6	average debt maturity = 6 years
γ	0.08	government revenue/output = 32%
μ	0.08	share of time devoted to work = 0.33
ρ	0.5	labor supply elasticity = 0.7
$\bar{g}$	21.0	necessary government expenditure/output = 21%

4 Optimal tax and debt policies

In this section, we provide a discussion of the optimal tax and debt policies and the corresponding equilibrium thresholds in a quantitative version of the model. Given a guess for the thresholds, we know prices, and then we can compute optimal tax and debt policy. Given those policies and their associated value functions, we can then generate a new guess for the thresholds and iterate on those until convergence. Now, we describe the parameterization of the quantitative model and its policy prescriptions.

One period in the model corresponds to one year. We parameterize the model to capture the key features of the European experience following the 2008–09 recession. We consider as our benchmark an economy with 80 percent debt to output in normal times — that is, before the 2008 shock. We normalize output of such an economy to 100, so that all debt values can be interpreted as a fraction of output in this benchmark economy.

We follow Conesa and Kehoe (2017) for many of these targets. The parameters are summarized in Table 1. We choose $\beta = 0.98$ to target a risk free rate of 2 percent. We choose $\pi = 0.03$ so that the real interest rate jumps to 5 percent when in the crisis zone. The increases in interest rates in 2011–12 for Spain or Italy were even larger than that. We set $\delta = 1/6$, so that the average debt maturity is six years. We set $p = 0.2$ so that the expected duration of the recession is five years. When the recession hits, productivity drops by 5 percent; $A = 0.95$. Also, a default this period or in the past implies 5 percent less productivity; $Z = 0.95$.

Chetty et al. (2012) argue for a labor supply elasticity of 0.7. Our choice of $\rho = 0.5$ is consistent with that value. That implies that upon the onset of the recession or because of a default, labor supply drops by a bit less than 5 percent, so that output falls by around

10 percent (both in a recession and because of a default). This number is within the range of the output drops observed in European economies and also consistent with the output losses reported in the literature. Papers that endogenize the output loss of a default, such as Mendoza and Yue (2012) and Sosa-Padilla (2018), find output losses between 6 and 12 percent of output. To simplify the analysis, we make the productivity loss permanent. In reality, the output losses due to defaults last only for a limited number of years, and countries eventually regain access to international lending markets.

We choose $\mu = 0.08$; this implies that the representative household works 33 percent of its time in the benchmark economy, which is a value that is standard in the literature. The parameter γ governs the relative weight of public consumption in the household's utility function. We choose $\gamma = 0.08$ so that government revenues as a share of output are 32 percent of output in normal times. We assume that the non-discretionary part of government expenditure is 21 percent of output in normal times, which pins down $\bar{g}$.

4.1 Simple version of the model

To illustrate the mechanics of preemptive austerity, we focus on a simplified version of the model with one-period bonds — that is, $\delta = 1$ — and no minimum government consumption, $\bar{g} = 0$. The characterization of optimal policy builds on the definition of three areas:

1. Levels of debt below which the sovereign can safely ignore sunspots, denoted by $\hat{b}(1)$. The sovereign can ignore them because even in the event of a panic, the level of debt is low enough that default would be suboptimal. In this area it is optimal to roll over debt, and that is why we call it the *rollover zone*.

2. The levels of debt for which the sovereign can use preemptive austerity to avoid panics from becoming self-fulfilling, by setting high taxes at the beginning of the period. This *preemptive austerity zone* is the segment between $\hat{b}(1)$ and the top of the safe zone, $\bar{b}(1)$.

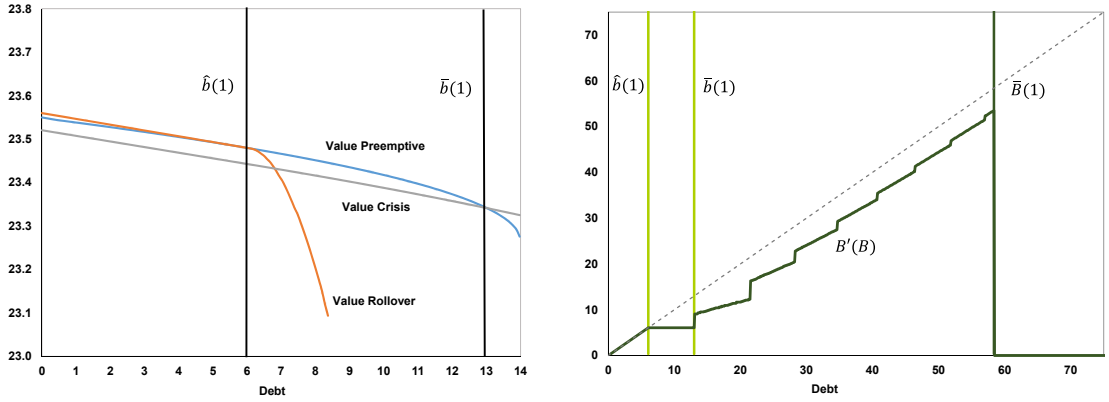
3. The *crisis zone* between $\bar{b}(1)$ and $\bar{B}(1)$.

The rollover zone and the crisis zone are exactly as in Cole and Kehoe (2000) and Conesa and Kehoe (2017). What is new is the preemptive austerity zone. This is an area where the sovereign sets the tax rate at the beginning of the period high enough so that if a panic were to occur, it would be optimal to repay the debt instead of defaulting. In the absence of the ability to set a high tax rate at the beginning of the period, and if the constant tax rate were set at the same level as the government chooses at $\hat{b}(1)$, the preemptive austerity zone would become part of the crisis zone. The highest supportable level of debt $\bar{B}(1)$ would also fall.

To further characterize this preemptive austerity zone, we depict three value functions

Figure 1: Value functions and optimal debt policy

(a) Value functions (b) Debt Policy



in Figure 1. The first one is the value of rolling over the debt (value rollover). The second is the value of setting the tax at the level that preempts crisis (value preemptive). And the third is the value if the economy is vulnerable to a crisis (value crisis). The intersection of value rollover and value preemptive determines $\hat{b}(1)$, and the intersection between value preemptive and value crisis determines $\bar{b}(1)$.

At the exact point where the level of debt reaches $\hat{b}(1)$, if a panic were to occur, the sovereign would be indifferent between repaying and defaulting, given the rollover tax. In the *preemptive austerity zone*, the sovereign chooses a tax higher than the rollover tax, but only high enough that it still keeps the indifference between repaying and defaulting if there were a panic. This strategy is preferable to lowering taxes and risking a default for all levels of debt in the preemptive zone.

We also provide here the optimal debt policy. Consistent with Cole and Kehoe (2000), it shows how in the crisis zone, it is optimal to bring down the debt in a finite number of periods, and how it is optimal to roll over the debt in the safe zone. In the preemptive austerity zone, given the parameter values, debt is run down in one period to $\hat{b}(1)$. This feature is not necessarily optimal always. In particular, in our benchmark economy, the level of debt is much larger, and the preemptive austerity zone is also much wider, so that the optimal policy is to run down the debt asymptotically.

4.2 Optimal debt policy in normal times

Now, we turn to the discussion of the results in our benchmark economy, both in normal and in recession times. In normal times productivity is expected to remain constant in the future (unless a default occurs). Consequently, the analysis of the mechanism is much simpler in this case, since consumption smoothing concerns are absent. We start by discussing this case.

Figure 2 plots the optimal policy as a function of the level of debt. Remember that we are normalizing output in our benchmark economy to 100. The crisis zone is defined in the same way as in Cole and Kehoe (1996, 2000) and Conesa and Kehoe (2017). Inside the crisis zone, the level of debt is high enough that a panic would be self-fulfilling in the sense that it would trigger a default. Therefore, the debt commands a premium that exactly compensates for the probability of a panic. In that area, the country risks a costly default, so it is optimal to pay down the debt to avoid that possibility. As shown in Cole and Kehoe (2000) and Conesa and Kehoe (2017), it is optimal to run down the debt in a finite number of periods to exit the crisis zone. The separable form of the utility function implies that the optimal way to do that is to fix the tax rate and fix the level of government expenditure to generate a surplus that reduces the debt in the desired number of periods.

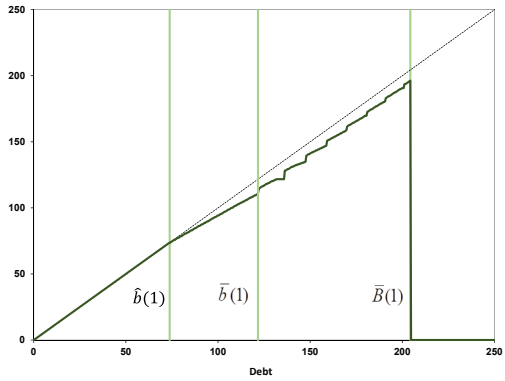
Making our debt have a maturity of six years, as sovereign debt in Spain and Italy did in 2010, increases all of the thresholds — $\hat{b}(1)$, $\bar{b}(1)$, and $\bar{B}(1)$ —, and lets us compare the debt levels in the data with those in the model. It is worth pointing out that Cole and Kehoe (1996) argue that increasing debt maturity even further makes $\bar{b}(1)$ approach $\bar{B}(1)$ and thus eliminates the possibility of self-fulfilling crises. As we see in Figure 2, however, the crisis zone is still large with debt with a maturity of six years. With debt of a maturity of 30 years, it is much smaller.

The jumps in the policy functions are the result of the discrete nature of the number of periods needed to run down the debt. Consider, for example, levels of debt above the lower threshold $\bar{b}(1)$, which is 121 percent of output in the benchmark economy. For levels of debt slightly above 121, it is optimal to run down the debt and exit the crisis zone in one period. If debt is a little larger, then the tax is a little larger, and government expenditure is a little smaller, but still it is optimal to exit the crisis zone in one period. As debt increases, though, eventually taxes are too high, and government expenditure is too low. Then, it becomes optimal to run down the debt in two periods with a lower tax and a higher government expenditure, which implies a lower surplus.

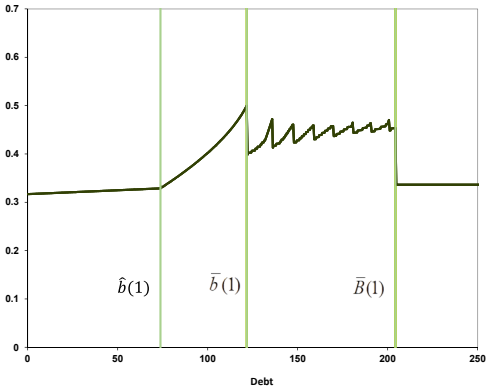
This behavior inside the crisis zone is the same as in Conesa and Kehoe (2017). What is different here is the behavior inside the safe zone, below the lower threshold $\bar{b}(1)$. Notice that the behavior closer to zero debt is different from the behavior close to $\bar{b}(1)$. For low

Figure 2: Optimal policy in normal times

(a) Debt policy function



(b) Tax rate



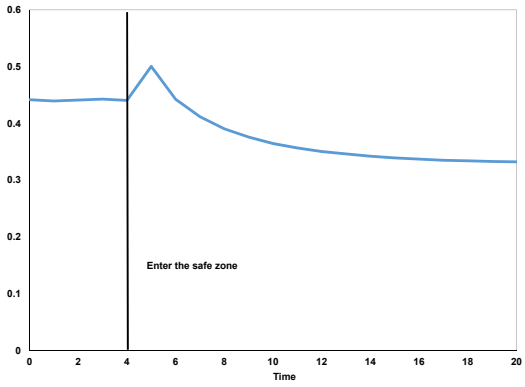
enough levels of debt, the government can safely ignore the possibility of a panic. In that case, even in the event of a panic, the government would still service the debt to avoid the cost of a default. Thus, given that productivity will be constant forever, it is optimal to roll over the same level of debt forever with a constant tax rate and government expenditure. This behavior is also consistent with Conesa and Kehoe (2017).

In contrast, with a larger level of debt — in our numerical exercise, around 80 — it is not safe to ignore the possibility of a panic. For larger levels of debt, if taxes were set ignoring the possibility of a panic, a debt crisis could occur, since servicing the debt is too costly. The optimal behavior, then, is to increase taxes enough so that if there were a panic, it would be optimal to service the debt and avoid a default. In other words, the government is setting the tax high enough to push the lower threshold to the right, enlarging the safe zone. We refer to this type of behavior as preemptive austerity, and the lower threshold $\bar{b}(1)$ is the level of debt at which preemptive austerity ceases to be worthwhile. Notice that without preemptive austerity, $\bar{b}(1)$ would have been 80 instead of 122, the highest debt level for which the stationary behavior rather than preemptive austerity is optimal.

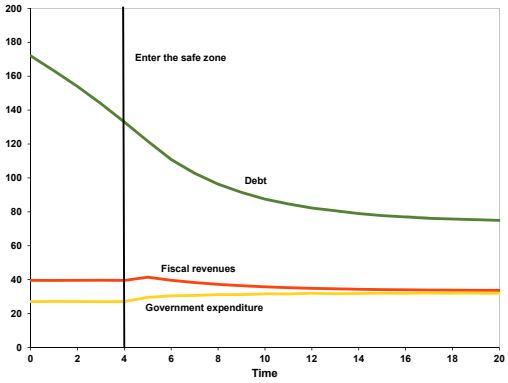
Notice that this behavior is ex-ante optimal since it is preferable to deter panics, but it is ex-post suboptimal since taxes are unnecessarily high ex-post. That explains the associated fiscal policy. The tax has been set high enough to deter panics, but ex-post, the government finds itself with larger fiscal revenues than the ex-post optimal. One possibility could be to set correspondingly high government expenditure and roll over debt indefinitely. It is better to run down debt instead, to avoid these ex-post suboptimal high taxes, and that is what generates austerity inside the safe zone. Moreover, debt and taxes converge asymptotically to the point where panics can be safely ignored, at which point preemptive austerity is not

Figure 3: Time path of fiscal variables

(a) Tax rates



(b) Fiscal variables



necessary, and that constitutes a steady state with rollover of debt in perpetuity.

To further illustrate the mechanism, let us look at a specific policy path over time. We arbitrarily pick an initial level of debt of 180, somewhere in the middle of the crisis zone. Figure 3 plots the evolution over time of tax rates (on the left panel) and debt, fiscal revenues and government expenditures (on the right panel). In period 0, the country is in the crisis zone. The government sets constant taxes and government expenditure, generating a fiscal surplus that allows the country to exit the crisis zone in four periods. Then, in period 5 the country is in the preemptive austerity zone and needs to set up a tax rate of 50 percent to deter panics. From that point onward, government expenditure increases asymptotically, while the tax rate, tax revenue, and debt fall asymptotically. The level of debt converges asymptotically to the point where the possibility of a panic can safely be ignored.

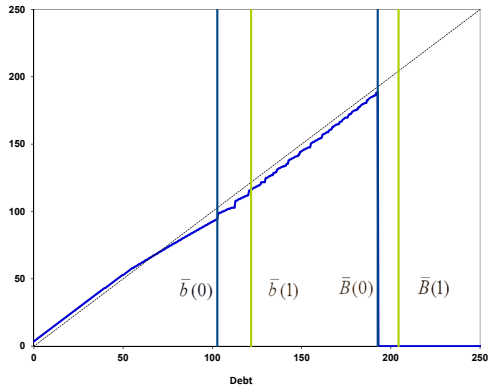
4.3 Optimal tax and debt policy in a recession

Figure 4 plots the optimal debt policy in a recession (left panel), and the tax policy (right panel). To make the comparison easier, we have included the tax policy in normal times in the right panel. The x-axis displays the level of debt today. Remember that the magnitudes of debt are relative to output in the benchmark economy of 100.

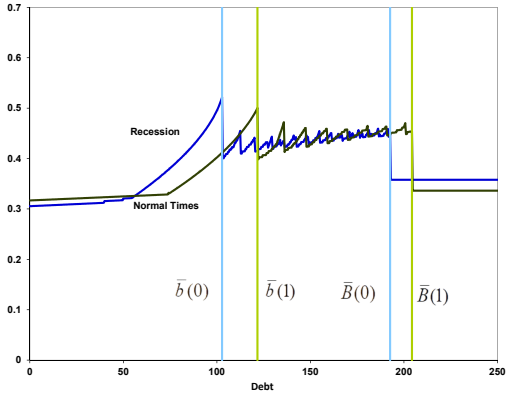
As discussed in Conesa and Kehoe (2017), when a recession unexpectedly hits the economy, both the lower threshold and the upper threshold immediately shift to the left. As a result, there is a zone at the top of the crisis zone, between $\bar{B}(0)$ and $\bar{B}(1)$, where the optimal policy is automatic default; the country is not solvent given the lower productivity. Then, inside the crisis zone, the optimal policy is still to repay debt, but that will happen

Figure 4: Optimal policy in recessions

(a) Debt policy function



(b) Tax rate



at a much slower pace for as long as the recession continues. Also, some levels of debt that were safe in normal times, debt between $\bar{b}(0)$ and $\bar{b}(1)$, are not safe anymore, and the country finds itself automatically inside the crisis zone with a sudden spike in interest rates.

During recessions there is a consumption smoothing motive that is not present in normal times. This provides an incentive to lower taxes and increase debt, more so since that stimulates hours worked and output. In the right panel of Figure 4, we observe that there is a steady state level of debt in the safe zone. For low levels of debt, the country is not vulnerable to panics, and therefore it is optimal to increase the level of debt during recessions. On the other hand, for higher levels of debt still inside the safe zone, preemptive austerity is optimal. Those two forces together generate convergence to a unique steady state level of debt slightly above 60 for as long as the recession persists.

The comparison of the tax rates under both cases is revealing, which is why we plot them in Figure 4. Consider the situation where a country is in normal times and suddenly is surprised by a recession. For low levels of debt, the country was in a steady state rolling over debt forever. Unexpectedly, a recession hits this country, and the optimal policy response implies lowering the tax rate (which stimulates labor supply) and increasing the level of debt to smooth consumption (both private and public) by borrowing against future income once the recovery occurs. This is the standard policy response in Conesa and Kehoe (2017), and in many other models where a consumption smoothing motive operates.

For higher levels of debt still inside the safe zone, however, notice that the optimal policy response could be exactly the opposite. There is a large range of values of debt below the lower threshold $\bar{b}(0)$ for which the optimal policy involves an increase in the tax rate. Since a recession lowers that threshold, shrinking the safe zone, we find that preemptive austerity

might be optimal for lower levels of debt than in normal times. Thus, we observe a range of values of fundamentals, level of debt and severity of the recession, for which the response to a severe economic crisis is costly austerity even though the country has access to cheap credit. Our exercise shows that the logic goes the other way around: it is because of the austerity painfully imposed during a recession that the country can still avoid the possibility of a default and consequently retain access to credit at a low interest rate.

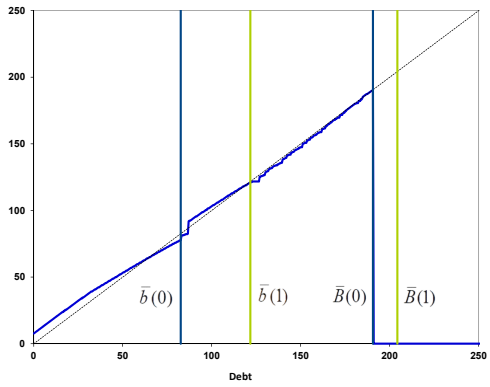
Consider now our specific benchmark for parameterization of the model. We took as a benchmark an economy that starts before the recession with a level of debt of 80 (relative to output in normal times of 100). A debt level of 80 is slightly above the threshold where it is safe to ignore panics. As a result there is a little bit of preemptive austerity, but the tax rate is not much larger than ignoring panics — see Figure 2(b) — and there is a small budget surplus. Debt is falling, but it is nearly constant — see Figure 2(a). When the recession hits, the optimal policy with a level of debt of 80, which is now almost 90 percent of output since output falls by around 10 percent, prescribes significant increases in taxes; see Figure 4(b). That does not mean that it is optimal to have a large budget surplus, since the consumption smoothing component is still operative and large surpluses are not optimal. As a result, debt is not going to be drastically reduced; see Figure 4(a).

Consider, for example, the case of Spain. In 2007 the debt to GDP ratio was as low as 36 percent, which is well in the range of values for which the possibility of a panic can be safely ignored. The recession was severe and prolonged, however, and debt jumped on impact to 40 percent of GDP in 2008. That would still leave plenty of room for consumption smoothing by running deficits. Indeed, debt increased to 70 percent of GDP by the end of 2011, but then it increased drastically, reaching 90 percent of GDP by the end of 2012. In the context of our numerical exercises, Spain had initial room to run deficits to smooth consumption in the face of a recession, as it did. It went too far, however, and exceeded what would have been prudent. Within the context of our numerical results, allowing debt to go as high as 90 percent of GDP without implementing austerity measures placed the government directly in the crisis zone. Indeed, interest rates started increasing rapidly by the end of 2010, reaching a peak of 6.8 percent in July of 2012, at which point a potential crisis could have unfolded if it had not been for the decisive intervention of the European Central Bank under Draghi.

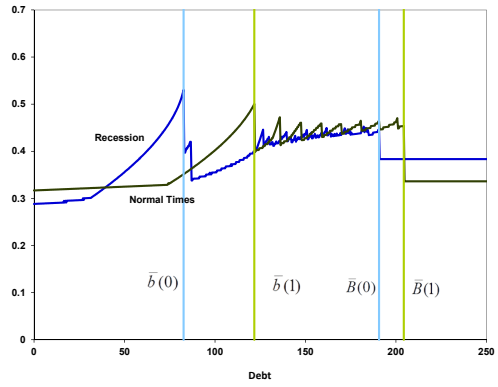
The case of Spain contrasts dramatically with that of Italy. In 2007 Italy had a level of debt of 103 percent of GDP. Within the context of our numerical exercise, such a level of debt would have called for austerity even before a recession, and more so after it. Finally, Germany's debt to GDP ratio increased from 64 percent in 2007 to 82 percent in 2010, but it started going down afterwards, and that might have been the reason why Germany managed to avert the financial troubles of Spain and Italy.

Figure 5: Policy functions in more severe recessions

(a) Debt policy function



(b) Tax rate



4.4 More severe recessions

Consider now the case when the recession is more severe and the probability of a recovery is higher. We simply assume that in a recession, productivity falls by 10 percent (compared with 5 percent in the benchmark) — that is, $A = 0.9$ — and the probability of a recovery is 40 percent (compared with 20 percent in the benchmark) — that is, $p = 0.4$. Notice that this productivity drop, together with our elasticity of labor supply, would imply a recession where output drops between 15 and 20 percent. We compare this case with the benchmark to think about the differences in fiscal response to the 2008–12 recession between countries like Germany, where the recession was less severe, and southern European countries like Spain or Italy, where the recession was much more severe.

In a severe recession, the government still has incentives to increase taxes, but because of the severity of the recession, fiscal revenues drop much more than in the benchmark, and the pace of debt repayment is much slower. Figure 5 displays the results. In the left panel, we report debt policy in recession times. Notice that since normal times are an absorbing state, the debt and tax policies in normal times are not affected by the severity of the recession.

Compared with the benchmark scenario, a more severe recession shifts the thresholds to the left by a larger magnitude, and notice that the optimal response is still to increase tax rates. In fact, the range of values of debt for which it is optimal to increase taxes upon the onset of a recession is larger.

In contrast to the benchmark, however, there is an area inside the crisis zone (for levels of debt slightly above the lower threshold in recessions) where the government finds it optimal to gamble for redemption, hoping for a recovery, and it does so until the point where debt is safe in normal times. In this area, the optimal tax rate is still high, but there are fiscal

deficits and debt goes up, even though interest rates are high. This happens because of the standard arguments discussed in Conesa and Kehoe (2017). In that area austerity is so costly that the optimal policy gives up on austerity and increases debt; the government does so in the hope that a recovery will happen soon.

When the recession is severe and prolonged and the government anticipates — or at least is willing to gamble — that the economy will recover quickly, then it is not optimal to engage in austerity once the debt level has passed a certain level. In the quantitative example we provide in this section, once debt has reached 90 percent of GDP, preemptive austerity is not optimal. Consequently, our analysis can explain the behavior of Italy, which entered a severe recession with a debt level of 103 percent of GDP. Since Spain started a similar recession with a much lower debt level, however, our analysis suggests that the Spanish government would have been wise to engage in preemptive austerity in 2010 to avoid the debt crisis that it experienced in 2011 and 2012.

5 Conclusions and directions for future research

We have used a simple model of rollover risk to illustrate what we call *preemptive austerity*, which refers to the optimal policy of high taxes up front to deter a potential rollover crisis. We have shown that this feature is consistent with the counterintuitive response to a recession of increasing austerity even though there is still access to cheap credit.

We believe such a model can shed light on the events that followed the recession of 2008–09, where many countries in the Eurozone found themselves more exposed to potential rollover risk. Our model suggests that differences in fundamentals (especially the initial level of debt and the severity of the recession) can determine whether fiscal austerity is the appropriate response to a recession or not. In particular, our results suggest that initially, Spain had room to run deficits and borrow to smooth consumption. That policy was sustained longer than was advisable, however, triggering the response of interest rates and the vulnerability observed during the summer of 2012. This reading contrasts with the case of Italy, where initial debt was too large to begin with.

As it engages in preemptive austerity in setting a high tax rate at the beginning of the period, the government in our model is able to commit to building up tax revenue that it can use to pay off debt that becomes due at the end of the period. Since this is the only sort of commitment that the government can make, it does not matter if the government at the end of the period is the same government or a new one. This commitment induces lenders to remain calm and not to panic even if there is a realization of the sunspot that would cause them to panic if the government had not committed to building up the tax revenue. The

government realizes that the lenders will purchase its new debt at a high price when it, or a new government, chooses how much new debt to offer at auction. Since the tax rate is higher than it would have chosen at the beginning of the period if it had been assured that there would be no panic, the government finds it optimal to use some of the high tax revenues to reduce its debt. It also spends more than it would have done in the out-of-equilibrium event that the auction had failed.

Our results show that giving the government a little ability to commit can improve outcomes in an otherwise standard sovereign debt and default model.

We can view preemptive austerity as an alternative policy to accumulating foreign reserves to ward off a self-fulfilling debt crisis. There are differences between the two policies, however. Alfaro and Kanczuk (2009) study a simple model of solvency crises in which the government has the option to accumulate reserves to insure against default on its one-period debt. They find that the optimal government policy is not to accumulate reserves but to use the resources that would be used to accumulate reserves to instead pay down the debt. There are notable studies that provide exceptions to the Alfaro-Kanczuk results: Samano (2022) analyzes a model in which the government is composed of an impatient fiscal authority and a more patient central bank. In his model, the fiscal authority runs up the debt, but the central bank is able to partially undo this by accumulating reserves and thereby lowering the probability of a default. Bianchi and Sosa-Padilla (2023) propose a model where the government issues risky multi-period debt, and it finds that it is optimal to accumulate safe, one-period foreign bonds as reserves to lower the probability of a solvency crisis. Barbosa et al. (2023) extend the analysis to rollover crises. As we have noted, however, this role for reserves disappears in a model where the government issues one-period debt. It is worth pointing out that in both Samano's model and Bianchi and Sosa-Padilla's model, the optimal level of reserves follows a stationary stochastic process, while in our model, the surpluses converge to zero. It is also worth pointing out that our model, at least as we have formulated it, has nothing to say about optimal policies to ward off attacks on exchange rate pegs, although there is a rich literature on using foreign reserves to do this. The general topic of comparing fiscal policies for avoiding debt crises with reserve accumulation policies merits more research.

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