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Defaulting on Covid debt

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ABSTRACT

The COVID-19 pandemic causes sharp reductions in economic output and sharp increases in government expenditures. These increase the riskiness of sovereign debts, especially in emerging economies. This paper proposes a framework to study debt sustainability. The economy is subject to productivity and expenditure shock. The government sets distortionary labour taxes and decides whether to repay its past domestic and foreign obligations. Foreign default is more likely after a negative productivity shock, while domestic default is more likely after a negative expenditure shock. This mechanism finds support in the data. Recent proposals that would ease the burden of foreign debt after COVID-19 would not prevent a wave of domestic defaults.

1. Introduction

In response to the COVID-19 pandemic, governments around the globe imposed containment measures. These lockdowns reduce economic activities and increase budget deficits. Due to the commitment problem, emerging economies find it hard to issue debt to smooth the impact of the shock. This paper studies the effects of output and government expenditure shocks on domestic and foreign debt sustainability.

The International Monetary Fund projects that the world output will contract by 3.0% in 2020. To mitigate the economic costs of lockdown measures, governments provide financial rescue packages at an unprecedented scale. Fig. 1 plots the expected scale of the real GDP growth against the expected primary deficit changes between 2019 (green stars) and 2020 (red circles). In 2020 emerging markets on aggregate are expected to lose 5.7 percentage points of GDP growth and to have a primary deficit larger by 4.3% of GDP relative to 2019. The new fiscal measures, which include additional spending and forgone revenue and loans, equity, and guarantees, account for 5.1% of GDP in emerging economies (IMF, 2020). The arrows show the average changes for country groups, and all point towards the southeast: lower growth and larger deficits.

How to finance such unprecedented deficits and stimulate economies? Governments stockpiled debt to finance rescue and recovery packages. Elevated debt levels coupled with falling output and rising government expenditure bring back the question of debt sustainability. Economists and policymakers call for urgent measures to be taken. The G-20 countries have suspended interest rate payments on bilateral debts. Bolton et al. (2020) argue for a broad "debt standstill" that will include private creditors and will be available to a large set of countries. The total stock of debt under consideration is $3 trillion.

The discussion focuses on external debt. Yet, the external debt accounts only for 40% of the total public debt in emerging economies, while the remaining debt is owed to domestic investors. Table 1 summarizes the stylized facts on the size and composition

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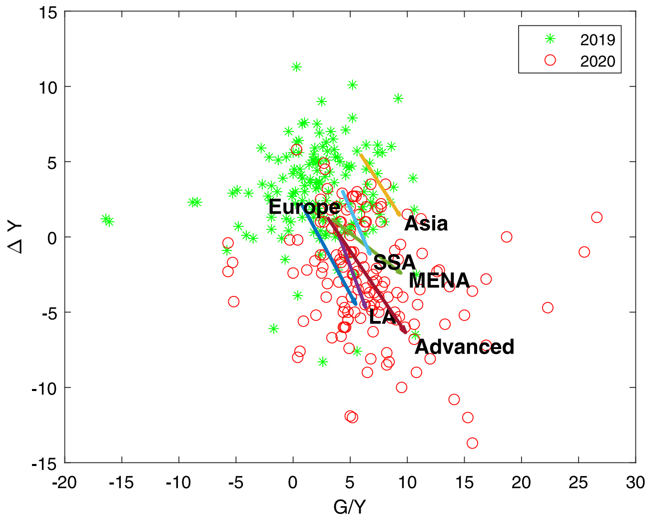

Fig. 1. GDP growth and primary deficit-to-GDP in 2019 and 2020. *Notes:* This figure plots the real GDP growth against the primary deficit, which is defined as the difference between government expenditures and tax revenues in the percentage of GDP for 152 economies. Green stars represent the actual data for 2019, and red circles are IMF projections for 2020 as of June 2020. The arrows represent the changes in the averages for advanced economies and five emerging market regions: Emerging and Developing Asia; Emerging and Developing Europe; Latin America and the Caribbean; the Middle East and Central Asia; Sub-Saharan Africa.
Source: The data are from IMF (2020).

Table 1
Domestic and foreign public debt in emerging economies.
Source: Own calculations based on Arslanalp and Tsuda (2014).

Debt-to-GDP		47%
Local currency debt (% of total)		63.5%
Foreign currency debt (% of total)		36.5%
Domestic holding (% of total)		60.7%
Foreign holding (% of total)		39.3%
USD-denominated debt	Domestic holding	37%
	Foreign holding	63%
Local currency debt	Domestic holding	81.5%
	Foreign holding	18.5%

Notes: The data is correct as of 2019Q4. The sample of emerging economies with available data on currency composition and residency of debt holders composition are: Argentina, Brazil, Bulgaria, Chile, China, Colombia, Egypt, Hungary, India, Indonesia, Latvia, Lithuania, Malaysia, Mexico, Peru, Philippines, Poland, Romania, Russia, South Africa, Thailand, Turkey, Ukraine, and Uruguay.

of public debt in 24 emerging economies in 2019. It also shows that in emerging markets, debt owed to domestic investors is usually denominated in local currency, and debt owed to foreign investors is usually denominated in foreign currency.[1]

Defaults on domestic debt are not uncommon and are associated with economic disruptions comparable to those after foreign default: a fact considered as "forgotten history" in macroeconomics (Reinhart and Rogoff, 2011a). Domestic and foreign debts are hardly similar. Foreign debt involves transferring resources into and out of an economy, which can help to achieve consumption smoothing over the business cycle. Domestic debt cannot accomplish this, as its issuance and repayment occur within an economy: domestic borrowing does not bring in additional resources.

We contribute to the literature by proposing a model to analyse foreign and domestic debt sustainability simultaneously. The economy is subject to two simultaneous shocks, and the government has limited commitment. After observing the shock realizations, the government decides on distortionary labour tax and whether to default on its foreign or domestic obligations (or both). If it defaults, the economy is subject to an output penalty in the form of reduced productivity. Otherwise, it has to increase taxes to finance repayment. Thus, repayment imposes endogenous distortion on the economy. However, in the case of domestic debt, this distortion is partially mitigated because resources flow back to domestic households. As a result, foreign default is more likely after a negative output shock, and domestic default is more likely after a negative expenditure shock.

[1] The literature distinguishes foreign and domestic debt on either legal or residency or currency basis. Here we apply the residency definition. For discussion, see Panizza et al. (2009).

We collect a dataset of default episodes, debt levels, tax rates and macroeconomic aggregates and test the model predictions in the past data. We find strong support for three model predictions: (i) that fluctuations in the GDP growth are associated with the probability of foreign default, (ii) that fluctuations in the government expenditure are strongly associated with the probability of domestic default, and (iii) that higher foreign debt increases the risk of foreign default, but not the risk of domestic default. Additionally, our model predicts that after any type of default, there is a fall in the tax rate, for which the data also offers moderate support.

This paper argues that after a Covid shock; a simultaneous output drop, and a government expenditure hike, even in case of a broad restructuring of foreign debt, governments might still choose to default on their domestic debt obligations selectively.

The model in this paper is in the tradition of the strategic sovereign default framework of Eaton and Gersovitz (1981). We contribute to the recent studies of the selective nature of sovereign defaults (Paczos and Shakhnov, 2016; Erce and Mallucci, 2018; Niepelt, 2016; Sunder-Plassmann, 2020). In our paper, similarly to D'Erasmo and Mendoza (2016, 2020) the riskiness of domestic debt takes centre stage. In contrast, the risk of domestic default is not driven by distributional incentives but by tax distortions arising in repayment.

We also contribute to the new Covid-macro literature; e.g. Arellano et al. (2020) embed the epidemiological SIR model into the standard sovereign default model to analyse foreign default risk. The interaction of debt, default, and Covid is also addressed quantitatively in Espino et al. (2020). These contributions focus on the riskiness of foreign debt. While the model in our paper is more stylized, it provides clear insights into the riskiness of domestic debt. This paper is also related to the literature on distortionary taxation with default (Pouzo and Presno, 2014; Karantounias, 2017), where a government defaults to mitigate endogenous tax distortions, albeit in a closed economy setting. Finally, since we solve the static optimal labour taxation problem, our model can be viewed as an extension of the Basic Model in Piketty and Saez (2013), that allows for defaultable debt.

2. The model

The model is a static open economy populated by a domestic representative household and a benevolent government. At the beginning of the period, the government has two outstanding obligations: domestic debt b^d towards the domestic representative household and foreign debt b^f towards foreign investors.[2] It takes two discrete decisions whether to default on each debt $d^d \in \{0,1\}, d^f \in \{0,1\}$. The government sets labour income tax at the marginal rate τ. We use the primary approach: we set up the government's problem in terms of allocations and, after having solved Ramsey allocations, we derive the optimal tax rate.

Households choose labour supply and consumption to maximize utility subject to budget constraint:

$$\max_{c,n} \quad u(c,n) \tag{1}$$

$$\text{s.t.: } c = wn(1-\tau) + (1-d^d)b^d + \pi, \tag{2}$$

where w is wage and π is a lump sum profit transferred from the representative firm owned by the household. Household's optimality condition reads:

$$u_n(c,n) = -u_c(c,n)w(1-\tau) \tag{3}$$

The optimality condition, together with the budget constraint, form the solution to the household's problem.

$$c = -\frac{u_n(c,n)}{u_c(c,n)}n + (1-d^d)b^d \tag{4}$$

The government later takes the solution to the household's problem as a constraint in its maximization problem; hence we subsequently refer to it as the Implementability Constraint (IC).

Firms produce using Cobb–Douglas production function with labour as the sole input and chose labour demand to maximize static profits:

$$\max_{n} \{\pi = f(n) - wn\} \tag{5}$$

$$\text{s.t.: } f(n) = \gamma A n^{\alpha}, \tag{6}$$

where A is the total factor productivity (TFP) shock and γ is the output cost in the case of a default:

$$\gamma = \begin{cases} \gamma^r & \text{if } d^d = 0 \text{ and } d^f = 0 \\ \gamma^d & \text{if } d^d = 1 \text{ and } d^f = 0 \\ \gamma^f & \text{if } d^d = 0 \text{ and } d^f = 1 \\ \gamma^d\gamma^f & \text{if } d^d = 1 \text{ and } d^f = 1, \end{cases} \tag{7}$$

where $\gamma^r = 1$ and $\gamma^d, \gamma^f < 1$. The solution to the firms' problem reads:

$$w = \alpha\gamma A n^{\alpha-1} \tag{8}$$

[2] Implicitly, we assume that government debt is the only savings vehicle for domestic households. Since the model does not include the household dynamic saving problem, other savings technologies would not qualitatively change the government's trade-offs.

Table 2
Parameter values.

	Parameter	Value
σ	Risk aversion	4
η	Consumption weight in utility	0.377
α	Labour share in production	0.64
b^f	Foreign debt	0.0205
b^d	Domestic debt	0.0205
γ^f	Foreign default penalty	0.94
γ^d	Domestic default penalty	0.99

$$\pi = (1-\alpha)\gamma A n^{\alpha}. \tag{9}$$

Optimal policy: The government acts as a Ramsey planner. To maximize household utility, the planner decides whether to default on foreign and domestic debts (d^f, d^d). The planner must respect implementability constraint (IC) (4) and the resource constraint (RC). The economy is subject to two shocks: the aggregate TFP shock A and the government spending shock g:

$$\max_{d^d, d^f} \quad u(c,n) \tag{10}$$

$$\text{s.t.: } \gamma A n^{\alpha} = g + c + (1-d^f)b^f \quad \text{(RC)} \tag{11}$$

$$c = -\frac{u_n(c,n)}{u_c(c,n)} n + (1-d^d)b^d \quad \text{(IC)} \tag{12}$$

In the primal approach, the households and firm first-order conditions are used to eliminate prices and tax rates. Determining optimal policy is reduced to a simple programming problem in which the choice variables are the allocations.

2.1. Functional forms and calibration

We assume the non-separable preferences, which is the standard form in the optimal taxation literature (Conesa et al., 2009):

$$u(c,n) = \frac{\left[(c)^{\eta}(1-n)^{(1-\eta)}\right]^{1-\sigma}}{1-\sigma} \tag{13}$$

Thus, the IC constraints reads:

$$c\left[1 - \frac{1-\eta}{\eta}\frac{n}{1-n}\right] = (1-d^d)b^d + (1-\alpha)\gamma A n^{\alpha} \quad \text{(IC)} \tag{14}$$

For each $d^f = \{0,1\}$ and $d^d = \{0,1\}$ Eqs. (11) and (14) completely characterize the solution. Foreign default directly relaxes the Resource Constraint, and the domestic default directly tightens Implementability Constraint. A negative TFP shock tightens both constraints: Resource Constraint via reduced resources and Implementability Constraint through wages (3). A negative government spending shock g directly affects only the Resource Constraint, reducing the available resources for consumption.

The problem does not admit an analytical solution, so we solve numerically imposing plausible parameter values. Table 2 summarizes parameter choices. We assume standard values in the optimal taxation literature for risk aversion $\sigma = 4$, consumption weight in utility $\eta = 0.377$ and labour share $\alpha = 0.64$. The model is static, and all past debt is due in a single period. We thus calibrate foreign debt level to reflect the amount of foreign debt maturing in 2020: Bolton et al. (2020) estimate that a debt standstill would free up 4.7% of emerging economies annual income. We set the target for b^f at 5% of y^*, where y^* is the reference output produced in repayment with $A = 1$ and $g = 0$. This gives $b^f = 0.0205$. For the clarity of exposition of the mechanism in the model, we assume that domestic debt is equal to foreign debt. With this set of parameters, the reference output is equal to $y^* = 0.418$. We plot the solution in the state space (A, g) setting the range for A between 0.85 and 1.15 and for g between 0 and 10% of y^*. The two remaining parameters are the productivity losses upon domestic and foreign default (γ^d and γ^f). These parameters govern how much debt is sustainable in the repayment equilibrium. Or, equivalently: how big shocks are necessary to trigger defaults. That output contracts after foreign as well as after domestic default has been established empirically, for example in Reinhart and Rogoff (2011a), Paczos and Shakhnov (2016). This empirical association can be a manifestation of two causal mechanisms. On the one hand, defaults happen during a series of bad shocks. On the other hand, they cause disruptions on domestic markets, causing the output to fall further.

Two theoretical mechanisms explain GDP loss upon default. First, imagine an open economy that trades in global goods and financial markets and where foreign investors hold government debt. When the government decides to default, the government and private sector are excluded from global goods and financial markets. The private sector can no longer import intermediate goods used in the production process and must rely on local, imperfect substitutes. This creates endogenous efficiency loss that translates to GDP loss (Mendoza and Yue, 2012). Second, imagine that banks intermediate domestic credit. Banks hold diversified portfolios of assets that also include government debt. When the government defaults, banks' balance sheets are hit. Banks become under-capitalized and are unable to intermediate additional investment. This creates a different type of endogenous efficiency loss in production (Sandleris, 2014; Gennaioli et al., 2014; Sosa-Padilla, 2018; Mallucci, 2015; Engler and Große Steffen, 2016; Thaler,

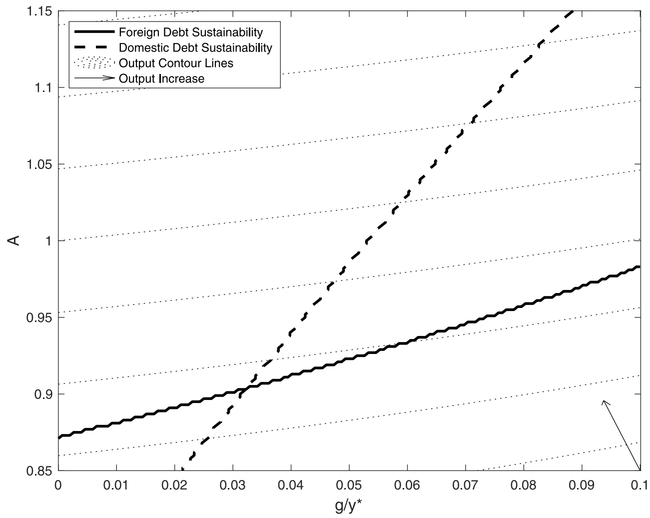

Fig. 2. Domestic and foreign debt sustainability.
Source: Authors' calculations.

2020). In this paper, for the sake of simplicity, we capture the GDP loss mechanism with an exogenous parameter.[3] We parametrize the output costs such that domestic and foreign defaults occur within the chosen state-space implying $\gamma^d = 0.99$ and $\gamma^f = 0.94$. Later, we show that the numerical parametrization of these two parameters does not qualitatively affect the mechanism described in the model. Chapter 3 also provides corroborating empirical evidence that domestic and foreign debt defaults are followed by substantial GDP losses.

2.2. Results

Fig. 2 plots the solution of the model. The graph is the theory equivalent of Fig. 1, which motivates this paper. The axes represent the two exogenous states, with the TFP level (A) on the vertical axis and the government spending (g) on the vertical axis, scaled by the reference output (y^*). The dotted lines represent output contours: equal output levels in repayment equilibrium in the state space of (A, g). Contours are plotted at 5% intervals. Output moves more than proportionally with the TFP level: a 5% increase in A increases output by more than 5% because labour supply increases as well. Output contours are upward sloping in the government expenditures g: output falls with g. This is because financing higher expenditures g requires higher taxes. This increases distortions and decreases the labour supply.

The solution of the model is characterized by the two lines: domestic and foreign debt sustainability lines. Debt is repaid when the state of the economy is above the respective sustainability line. The foreign debt sustainability line (solid) is almost parallel to the output contours, while the domestic debt sustainability line (dashed) steeply crosses output contours. Imagine a "good" state of the economy defined as $A = 1$ and $g = 0$. In the good state, both domestic and foreign debts are repaid. Compared to the good state, a sudden and large drop in A prompts the government to declare a default on its foreign debt. A sudden and large increase in g prompts the government to declare a default on its domestic debt. Note that both shocks reduce the economy's output.

Model parameters govern the positions of the sustainability lines. A higher default penalty (lower γ^i) shifts its respective debt sustainability line downwards: more debt can be sustained in repayment equilibrium, and larger shocks are necessary to trigger a default. A higher foreign debt level b_f has two effects. First, it reduces consumption because more resources are transferred out of the economy. Second, it reduces consumption because higher taxes are necessary to finance repayment. Reduced consumption makes the repayment option less attractive in both markets. Thus, higher b_f shifts up both sustainability lines. A higher domestic debt level b_d has only the second effect: it reduces consumption via higher taxes. Thus, it also shifts up both lines, albeit to a lesser degree. The remaining parameters (σ, η, α) do not affect the positions of sustainability lines.

Although the exact positions of the lines are dependent on parameters, the economic mechanism is not. The domestic debt sustainability line is always steeper than the foreign debt sustainability line. This is a striking result. It says that default on foreign debt is driven primarily by changes in productivity A, while default on domestic debt is driven primarily by changes in government expenditures g.

The intuition is the following. Households treat foreign and domestic default differently. When a government defaults on foreign debt, the economy suffers from decreased productivity, but households benefit through lower taxes. This trade-off is independent

[3] Our paper differs from the cited studies in one crucial respect: a government can issue separate bonds to domestic and foreign investors. Hence, the GDP loss is driven by the former mechanism.

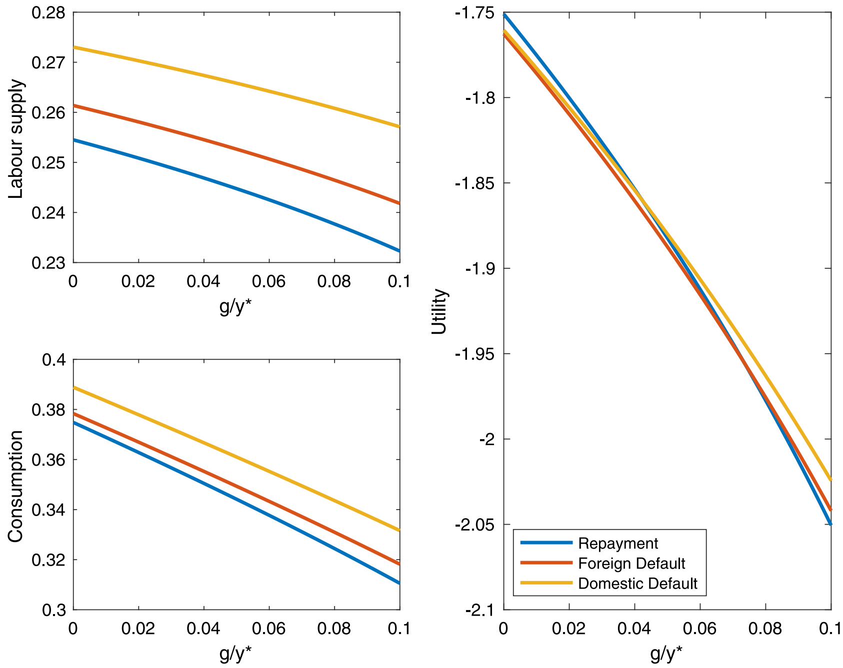

Fig. 3. Labour supply, consumption and utility for $A = 0.95$.
Source: Authors' calculations.

of the level of government expenditure g. Hence, foreign default is primarily driven by productivity shock. When a government defaults on domestic debt, households pay lower taxes, but they also lose their savings. As a result, they work more and become less responsive to tax changes. The latter effect is independent of the level of productivity A. Hence, domestic default is primarily driven by the expenditure shock.

We can visualize this intuition with the help of Fig. 3. For any given A, the slope of the labour supply (top left) and consumption (bottom left) in g is different across regimes. The chosen level of TFP in this figure is $A = 0.95$. At this TFP level, all: repayment, foreign default and domestic default occur in equilibrium at different levels of g. Labour supply decreases in g at the fastest pace in repayment and at the slowest pace in domestic default. Domestic default reduces the right-hand side of the IC constraint (14): households lose their savings and need to work more. When a government expenditure shock g reduces resources (via the RC constraint), a drop in labour supply is relatively small in domestic default, larger in foreign default and the largest in repayment.

Labour supply decreases with g. This reduces resources and disposable consumption. Utility decreases in g (right panel). As is the case for labour supply and consumption, utility decreases at the fastest pace in repayment and at the slowest pace in domestic default. When the economy is in a "good" state ($A = 0.95$ and $g = 0$), utility is the highest in repayment. The difference between utility in repayment and utility in domestic default narrows down quickly. As a result, for high levels of g domestic default is the preferred option. The effect is similar at different levels of A. Hence, the domestic debt sustainability line is almost vertical in Fig. 1.

On the other hand, the difference between utility in repayment and utility in foreign default narrows down slowly in g. Thus, a relative position of the two lines in the origin is the prime driver of the repayment vs foreign default trade-off. For high levels of A, repayment is the preferred option, and for low levels of A, foreign default is selected. The effect is similar across expenditure levels. As a result, the foreign debt sustainability line is almost horizontal in Fig. 1.

2.3. Default mechanics

Fig. 5 plots consumption, labour tax, and foreign and domestic default as a function of government expenditure. The upper panel plots the variables assuming a high level of TFP and the bottom panel assuming a low level of TFP. For the higher level of TFP, we observe only domestic default, while for the low level of TFP, we observe two defaults: domestic default at a lower level of g and foreign default at a higher level of g. Fluctuations in government expenditure mostly lead to domestic default. Given chosen parameter values (Table 2), despite two debt levels being the same, domestic default leads to bigger adjustment because of the smaller default costs associated with domestic defaults.

Fig. 4 plots consumption, labour tax, and foreign and domestic default decision as a function of TFP. The upper panel plots the variables assuming low government expenditure, and the bottom panel plots the variables assuming high government expenditure. The step functions correspond to the default type: the red dotted line for foreign default and the red dashed–dotted line for domestic default. As TFP falls, the resource constraint is tightened, which leads to a drop in consumption. Similarly, as TFP falls, the marginal

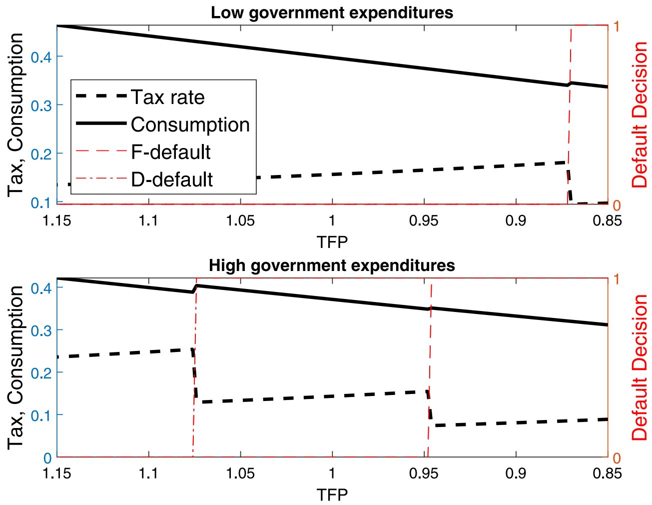

Fig. 4. Consumption and tax rates as a function of TFP. Notes: The order on the x axis is reverse. Low government expenditure corresponds to 0% of GDP and high government expenditure corresponds to 7% of reference GDP. The rest of the parameters are as in Table 2. The step functions corresponds to the type of default: the red dashed line represents foreign default; the red dashed–dotted line represents domestic default. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)
Source: Authors' calculations.

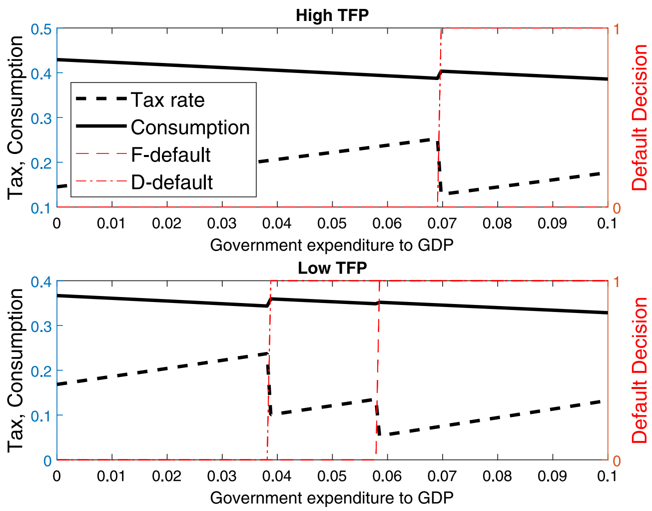

Fig. 5. Consumption and tax rates as a function of government expenditure. Notes: Low TFP corresponds to $A = 0.93$ and high TFP corresponds to $A = 1.07$. The rest of the parameters are as in Table 2. The step functions corresponds to the type of default: the red dashed line represents foreign default; the red dashed–dotted line represents domestic default. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)
Source: Authors' calculations.

product of labour declines, which results in the rise of labour tax to sustain the incentive compatibility constraint. This process continues as long as the default cost outweighs the cost of distortions. However, the larger is the TFP drop, the higher are the distortions: at some point, the government decides to default. In this case, the economy experiences a steep adjustment: a substantial decrease in labour tax and a small rise in consumption. The increase in consumption is mitigated by an extra drop in TFP due to default. Consequently, the size of the adjustments depends on the debt levels and the default costs. The smaller is the domestic debt level, the smaller is the labour tax decrease. The smaller is the foreign debt level, the smaller is the consumption increase. Smaller default costs lead to a larger rise in consumption.

Furthermore, for low levels of government expenditure (top panel), foreign default occurs only at a very low level of TFP. For high levels of government expenditure, when TFP declines, the government first decides to default on domestic debt and then on foreign one.

3. Empirical evidence

Our model describes a theoretical mechanism of domestic and foreign default in a unified framework. The Results and Default Mechanics subsections in the previous chapter offer a handful of testable predictions. We state four hypotheses derived from the model that can be directly tested in the data:

1. For a given level of government expenditures, fluctuations in the GDP growth rate are strongly associated with the probability of foreign default (and only weakly associated with the probability of domestic default). See Fig. 2.
2. For a given level of GDP growth, fluctuations in the government expenditure are strongly associated with the probability of domestic default (and only weakly associated with the probability of foreign default). See Fig. 2.
3. Higher foreign debt increases the risk of foreign default, but not domestic default. See Eqs. (11) and (12).[4]
4. For the given debt levels, there is a fall in the tax rate after any type of default. See Figs. 4 and 5.

We build a database of default episodes, outstanding debt, government expenditures, taxes (and some other auxiliary variables) by carefully merging and unifying multiple, concurrently available data sources. The data on start and finish dates of default episodes come from the updated database accompanying (Reinhart and Rogoff, 2011b), which covers up to 150 countries for the years 1800–2014. We focus on the postwar period. We calculate GDP growth rate as a log difference of the GDP in local currency in fixed prices from the Penn World Tables 8.1 (Feenstra et al., 2015). This variable is widely available across countries and time. We collect debt levels from both (Panizza, 2008) and Reinhart and Rogoff (2011b). Tax rates are collected combining three different sources for the data on tax rates: World Tax Database (2015) which includes 155 countries for the years 1960–2002, KPMG (2015) which includes 135 countries for the years 1993–2015, and CBT Tax Database (2015) which includes 45 countries for the years 1979–2014. All variables are annual.[5]

Since the model is static, it cannot be estimated using the state-of-art estimation and empirical validation techniques such as *indirect inference* (Le et al., 2016). Such techniques only require that the theoretical model can be simulated and so are well suited for dynamic models with rich structure. Our theoretical mechanism can be modelled and interpreted using a simpler, static setup, albeit rich in interactions. Thus, the model cannot be simulated and instead, we test whether the model predictions can find support in the data.

To test Hypotheses 1–3, we estimate the following regression equation:

$$Pr(Def^{j}_{i,t} = 1) = \alpha^{f}_{0} + \alpha^{f}_{1}\Delta GDP_{i,t-1} + \alpha^{f}_{2}\Delta G_{i,t-1} + \alpha^{f}_{3}B^{f}_{i,t-1} + \alpha^{f}_{4}\tau_{i,t-1} \tag{15}$$

separately for each type of default, where Pr is a probability of default, $Def^{j}_{i,t}$ is the indicator for the beginning of a default episode of type j (foreign or domestic), in the country i in period t, and $\Delta GDP_{i,t}$ is the rate of growth of real GDP per capita. $\Delta G_{i,t}$ is the change in the ratio of government expenditure to GDP and $B^{f}_{i,t}$ is the level of foreign debt to GDP. We further control for the level of distortions in the economy by the level of corporate income tax $\tau_{i,t}$.[6] Our independent variables are lagged one period to mitigate the possible endogeneity problem. We estimate five regressions for each default: a pooled logit, a random-effects logit and a probit, and a linear probability model and a logit model with country fixed effects. Our estimation sample with the full data coverage is 89 countries for the years 1981–2011, yielding a total of 2391 country-year observations with 17 domestic defaults and 41 external defaults.

Our model implies that foreign default is mainly driven by fluctuations in output; therefore, we expect α^{f}_{1} to be significant and negative and α^{f}_{2} to be zero. Domestic default is mainly driven by public expenditures; therefore, we expect α^{d}_{2} to be significant and positive, and we remain agnostic about α^{d}_{1}. Trivially, defaults are more probable with higher debt levels; therefore, we expect both α^{j}_{3} to be positive for foreign default, but not domestic default.

Tables 3 and 4 report the estimation results for foreign and domestic default respectively. A faster GDP growth per capita is associated with a lower probability of foreign default but does not statistically affect the probability of domestic default. These results are robust across five methodological specifications. An increase in the government expenditure-to-GDP is associated with the higher probability of domestic default but does not statistically affect the probability of foreign default. A positive association with domestic default probability is statistically significant at the 5%-level in three specifications and at the 10%-level in the remaining two. The level of foreign debt is associated with a higher probability of foreign default in the three specifications. The results are less clear-cut for the domestic default: in four specifications, the association is not statistically significant.

To test Hypothesis 4 we estimate the following regression equation:

$$\Delta\tau_{i,t} = \beta_0 + \beta_1\delta^{d}_{i,t} + \beta_2\delta^{f}_{i,t} + \beta_3\Delta GDP_{i,t} + \beta_4\Delta G_{i,t} + \beta_5 B^{f}_{i,t}, \tag{16}$$

[4] This can be seen by first: noticing that b^f affects trade-off in the Resource Constraint (11) but not Implementability Constraint (12), and second: is explained in the discussion on page 10.

[5] The first two sources are used as main and are complementary regarding time coverage. We use the third source as a supplement for missing countries and data points. For overlapping country-years, we take the tax rate claimed by at least two sources. If there is a missing data period and the tax rate before and after is the same, we interpolate this tax rate throughout the period.

[6] The rationale for using corporate tax rate is its broad coverage in the available datasets. The minor point is that corporate taxes are, to the best of our knowledge, always flat-rate taxes — unlike personal income taxes. In addition, empirical studies show that labour bears between 50 per cent and 100 per cent of the burden of the corporate income tax: https://taxfoundation.org/labor-bears-corporate-tax/.

Table 3
Probability of foreign default.
Source: Authors' calculations.

	Logit pooled	Logit RE	Logit FE	Linear FE	Probit RE
Δ GDP	−14.87***	−14.78***	−11.93***	−0.364***	−6.813***
	(2.838)	(2.900)	(3.194)	(0.0736)	(1.400)
Δ G	8.084	9.598	11.76	0.154	4.379
	(9.484)	(9.351)	(9.588)	(0.211)	(4.393)
For. debt	0.0151***	0.0141***	0.0000144	−0.0000289	0.00673***
	(0.00414)	(0.00542)	(0.00856)	(0.000191)	(0.00257)
Tax rate	1.125	1.587	3.701	0.0603*	0.724
	(1.668)	(1.836)	(2.301)	(0.0342)	(0.774)
N	2389	2389	748	2389	2389

Notes: Standard errors in parentheses. The dependent variable is a dummy variable that indicates the beginning of a foreign default. The sample is 89 countries in the years 1981–2011. Details of all variables construction and data sources are described in the main text. Standard errors are clustered at the country level. Columns represent different models as column titles indicate. In model (3), the identification is, by construction, only through defaulting countries, which yields a large drop in observations.
*p < .10, **p < .05, ***p < .01.

Table 4
Probability of domestic default.
Source: Authors' calculations.

	Logit pooled	Logit RE	Logit FE	Linear FE	Probit RE
Δ GDP	−6.895	−5.679	−3.773	−0.0315	−2.447
	(7.252)	(5.655)	(5.418)	(0.0454)	(2.306)
Δ G	26.48*	30.61**	32.00*	0.296**	13.74**
	(13.62)	(13.47)	(18.99)	(0.130)	(6.069)
For. debt	0.0180***	0.0151	−0.00670	−0.000128	0.00707*
	(0.00494)	(0.00924)	(0.0142)	(0.000118)	(0.00381)
Tax rate	0.938	2.366	5.570	0.0300	1.030
	(2.436)	(3.204)	(4.050)	(0.0211)	(1.257)
N	2389	2389	327	2389	2389

Notes: Standard errors in parentheses. The dependent variable is a dummy variable that indicates the beginning of a foreign default. The sample is 89 countries in the years 1981–2011. Details of all variables construction and data sources are described in the main text. Standard errors are clustered at the country level. Columns represent different models as column titles indicate. In model (3), the identification is, by construction, only through defaulting countries, which yields a large drop in observations.
*p < .10, **p < .05, ***p < .01.

Table 5
Corporate income tax changes.
Source: Authors' calculations.

Dom. Default	−0.0209***	−0.0208***	−0.0279***
	(0.00775)	(0.00801)	(0.00917)
For. Default	−0.00392	−0.00367	0.00690
	(0.00458)	(0.00466)	(0.00570)
Δ GDP		0.0298**	0.0233
		(0.0141)	(0.0202)
Δ G		0.00888	0.00378
		(0.0161)	(0.0582)
For. Debt			−0.000158***
			(0.0000530)
N	3458	3314	2322

Notes: Standard errors in parentheses. The dependent variable is a dummy variable that indicates the beginning of a foreign default. The sample is 89 countries in the years 1981–2011. Details of all variables construction and data sources are described in the main text. Standard errors are clustered at the country level. Columns represent different models with different sets of regressors.
*p < .10, **p < .05, ***p < .01.

where $\delta^j_{i,t}$ are indicators for a default of j-type (domestic and foreign) in country i in period t and the other variables are already familiar from Eq. (15). Our model predicts that after a default tax rate should go down so that β_1 and β_2 are negative. Table 5 reports the estimation results of Eq. (16). Interestingly, the corporate tax rate goes down after domestic default but not after foreign default. This result is robust for controlling for GDP growth and the growth of public expenditures (in column 2) and also for the level of debt (in column 3).

Table 6
GDP losses after defaults.
Source: Authors' calculations.

	FE	FE	FE	FE	FE
Dom. default	−0.0628***		−0.0610***	−0.0369***	
	(0.00916)		(0.00933)	(0.00852)	
For. default		−0.0186***	−0.0148***		−0.0135***
		(0.00492)	(0.00495)		(0.00520)
ΔG				−0.170***	−0.170***
				(0.0530)	(0.0531)
Dom. debt				−0.000158***	−0.000158***
				(0.0000448)	(0.0000449)
For. debt				−0.0000890*	−0.0000933*
				(0.0000477)	(0.0000478)
N	6436	6436	6395	3197	3197

Notes: Standard errors in parentheses. The dependent variable is the GDP growth rate. The sample is 89 countries in the years 1981–2011. Details of all variables construction and data sources are described in the main text. Standard errors are clustered at the country level. Columns represent different models with different sets of regressors.
*p < .10, **p < .05, ***p < .01.

The empirical exercise shows that the data offers strong support to Hypotheses 1–3 and some support to Hypothesis 4. Thus, we conclude that the data corroborates the mechanism described in the model.

Our dataset allows us also to test the relevance of the assumption that defaults lead to losses in the TFP. We estimate the following regression equation:

$$\Delta GDP_{i,t} = \beta_0 + \beta_1 \delta^d_{i,t-1} + \beta_2 \delta^f_{i,t-1} + \beta_3 \Delta G_{i,t-1} + \beta_4 B^d_{i,t-1} + \beta_4 B^f_{i,t-1}, \tag{17}$$

where the dependent variable is the growth rate of GDP, and independent variables are domestic and foreign default, change in the ratio of government expenditure to GDP and the levels of domestic and foreign debt to GDP. All regressors are lagged one period to avoid reverse causality, and the estimation is executed using country fixed effects. Table 6 presents the results. Indeed, one year after domestic default, GDP growth falls on average by 3–6 percentage points, and after foreign default, it falls by about 1.5 percentage points. An increase in the government expenditure ratio and in both debt levels is also strongly associated with slower GDP growth one year later.

4. Conclusions

This paper illustrates the mechanism that drives strategic foreign and domestic default in the presence of two shocks. Foreign default is more likely after a negative productivity shock, and domestic default is more likely after a negative government expenditure shock. This mechanism finds strong support in the data. A Covid shock, which reduces output and increases government expenditure, brings the economy closer to a total default. Even in the case of well designed foreign debt restructuring and "standstill" programmes, we can still expect a wave of domestic defaults.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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