

## RESEARCH STATEMENT: CÉSAR SOSA-PADILLA

I am an economist with research interests in international macroeconomics and fiscal policy. My research focuses on understanding sovereign debt crises, both in emerging and advanced economies. The overarching theme is that governments lack commitment (to policies and repayment promises) and therefore act opportunistically (by defaulting on their debts). This leads to rich dynamics between the government, domestic agents (households, firms, banks, etc.), and foreign agents (creditors, multilateral organizations, etc.). In my research I use data, theory, and computation to better understand these dynamics, and to improve the design of policies and instruments to alleviate sovereign risk.

In this document I organize my research portfolio thematically, discussing first the published and completed work within each theme and then briefly outlining the work in progress.

### 1 The Debt Dilution Problem

In “**Debt Dilution and Sovereign Default Risk**” [1] (published in the *JPE* in 2016 and co-authored with Juan Carlos Hatchondo and Leonardo Martinez) we measure the effects of debt dilution on sovereign default risk. The *debt dilution problem* appears because borrowers do not have the ability to commit to not dilute the market price of current debt issuances with future issuances. In the paper, the price of sovereign bond decreases (i.e., is diluted) when the government issues new bonds. If governments could commit to not dilute the price of current bond issuances with future issuances, this would allow them to sell bonds at a higher price in the present. But it is well understood that governments have limited ability to make such commitments. Thus, dilution has received considerable attention in both academic and policy discussions. While previous studies suggested that debt dilution may be an important source of inefficiencies in debt markets, they did not quantify the effects of dilution.

First, we present a calibrated sovereign default model with endogenous debt duration and dilution, which matches features of the data. Second, we modify this baseline model by assuming that, when the sovereign issues debt, it pays to the holder of each existing bond the difference between the post-issuance bond price and the counterfactual bond price one would have observed without issuances. With this compensation, bond prices do not decline with debt issuances and thus, the debt dilution problem disappears. We quantify the effects of dilution by comparing the simulations of the baseline and modified models. We find that if the sovereign could eliminate dilution, the probability of default would decrease 78% and the optimal duration of sovereign debt would increase by almost 2 years.

The compensation used to measure dilution in our paper may be difficult to implement in reality because it is determined using a counterfactual price. However, we show that the gains from eliminating dilution could be obtained with simpler compensation schemes that could be implemented through debt contract covenants. For instance, most gains from eliminating dilution can be obtained with debt covenants that penalize the government for either (i) choosing debt levels above a threshold or (ii) borrowing at bond prices below a threshold. We find that the first covenant is more effective in reducing consumption volatility and the second one is more effective in reducing the default frequency. The

analysis in our paper is also relevant for the study of other credit markets where the debt dilution problem is present.

**Future work.** My co-authors and I have plans to write a follow-up paper studying further the debt dilution problem. In particular, the model in our *JPE* article is an endowment economy (typical in this literature): this, in itself, diminishes the scope for welfare gains of eliminating dilution. We plan to quantify the welfare consequences of debt dilution with a production model in which sovereign risk has the potential to generate efficiency losses (due to missallocation of resources).

## 2 Debt Relief

Countries (emerging and advanced) typically emerge from severe crises (domestic or global) with high debt ratios. It is then natural for both academics and policy-makers to be concerned with mechanisms to reduce this high indebtedness or to ease the transition towards more manageable debt ratios: this is what I refer to as “debt relief.” Debt relief can take many forms: haircuts, restructurings, debt exchanges, maturity extensions, payment moratoriums, etc. Here I describe two papers that deal with this.

“**Voluntary Sovereign Debt Exchanges**” [2] (published in the *JME* in 2014, also with Hatchondo and Martinez) shows that some recent sovereign debt restructurings were characterized by (i) the absence of missed debt payments prior to the restructurings, (ii) reductions in the government’s debt burden, and (iii) increases in the market value of debt claims for holders of the restructured debt. Since both the government and its creditors are likely to benefit from such restructurings, we label these episodes as “voluntary” debt exchanges. We present a model in which voluntary debt exchanges can occur in equilibrium when the debt level takes values above the one that maximizes the market value of debt claims. In contrast to previous studies on debt overhang, in our model opportunities for voluntary exchanges arise because a debt reduction implies a decline of the sovereign default risk. This is observed in the absence of any effect of debt reductions on future output levels. Although voluntary exchanges are Pareto improving at the time of the restructuring, we show that eliminating the possibility of conducting voluntary exchanges may improve welfare from an ex ante perspective. Thus, our results highlight a cost of initiatives that facilitate debt restructurings.

In recent related work with the same co-authors, we are now quantifying the merits of a debt relief policy widely proposed (by the World Bank, the G20, and others) as a way to cope with the high debt ratios after the COVID-19 shock: a debt standstill. In “**Sovereign Debt Standstills**” [3] (currently *R&R* at the *JPE-Macro*) we evaluate standstills (payment suspensions without write-offs on the face value of debt obligations) after a negative shock calibrated to mimic the effects of COVID-19 on the sovereign access to debt markets, as reflected in sovereign spreads. We find that a debt standstill would produce welfare gains for the sovereign. However, except when the standstill avoids an imminent default, it would also produce capital losses for creditors: this is consistent with the creditors’ observed reluctance to participate in the WB-G20 standstill initiative. Standstills generate capital losses because debt levels are higher after the standstill (because postponed payments earn interest). Bondholders suffer capital losses because they are not properly compensated for the increase in the default probability not only of

postponed payments but also on all other payments. Creditors' losses after a standstill may be significant because after large negative shocks, the price of debt becomes very sensitive to changes in the debt level.

We find that debt write-offs tend to dominate standstills. Both policies provide effective debt relief and are beneficial to the sovereign. However, while write-offs achieve debt relief through a persistent decline in debt payments, standstills achieve debt relief only through a temporary reduction in debt payments and tend to generate higher default risk after the payment suspension is over. We show that when standstills are combined with write-offs, they can produce a Pareto improvement for the sovereign and creditors (as a group). Overall, our results cast doubts on the emphasis on avoiding write-offs during standstills, and even more so after large shocks such as COVID-19.

### 3 The Sovereign-Bank Nexus

The Sovereign-Bank Nexus (also called the “diabolic loop” or “doom loop”) emerges from the tight connection (and mutual fragility) that exists between governments and domestic banks. On the one hand, domestic banks are typically highly exposed to domestic sovereign debt: a sovereign default (or haircut) diminishes the market value of banks' assets and affects their lending capacity. This typically triggers a credit crunch and depresses the economy. On the other hand, shocks to the banking sector (due to losses on their investments, runs on deposits, etc) may create the need for the government to bailout the banks, which usually creates the need for new debt issuances, increases the riskiness of the entire debt stock, and hence further affects the banks' balance sheets.

A massive literature has emerged around this issue, both in the academic and policy circles. I have three projects on this topic: one is already published, the second one is a completed working paper that my co-authors and I have been presenting at various conferences, and the third is still in the work-in-progress phase.

**“Sovereign Defaults and Banking Crises”** [4] (published in the *JME* in 2018) starts from the observation that episodes of sovereign default feature three key empirical regularities in connection with the banking systems of the countries where they occur: (i) sovereign defaults and banking crises tend to happen together, (ii) commercial banks have substantial holdings of government debt, and (iii) sovereign defaults result in major contractions in bank credit and production. In this paper I provide a rationale for these phenomena by extending the traditional sovereign default framework to incorporate bankers who lend to both the government and the corporate sector. When these bankers are highly exposed to government debt, a default triggers a banking crisis, which leads to a corporate credit collapse and subsequently to an output decline. When calibrated to the 2001-02 Argentine default episode, the model is able to produce default in equilibrium at observed frequencies, and when defaults occur credit contracts sharply, generating output drops of 6% below trend, on average. Moreover, the model matches several moments of the data on macroeconomic aggregates, sovereign borrowing, and fiscal policy. The framework developed here can also be useful for studying the optimality of fractional defaults and the political economy of domestic debt repudiation.

The output collapse that comes after a default is engineered through the banking sector exposure to government debt. It is however not trivial to determine the optimal level of exposure to government

debt. My work-in-progress (discussed at the end of this section) addresses this key policy question.

In “**Optimal Bailouts in Sovereign and Banking Crises**” [5] (working paper, joint with Sewon Hur and Zeynep Yom) we study optimal bailout policies in the presence of banking and sovereign crises. First, we use European data to document that asset guarantees are the most prevalent way in which sovereigns intervene during banking crises. Then, we build a model of sovereign borrowing with limited commitment (extending my previous work in [4]), where domestic banks hold government debt and also provide credit to the private sector. Shocks to bank capital can trigger banking crises, with the government sometimes finding it optimal to extend guarantees over bank assets. This leads to a trade-off: Larger bailouts relax domestic financial frictions and increase output, but also imply increasing government fiscal needs and possible heightened default risk (i.e., they create a ‘diabolic loop’). We find that the optimal bailouts exhibit clear properties. Other things equal, the fraction of banking losses that the bailouts cover is: (i) decreasing in the level of government debt; (ii) increasing in aggregate productivity; and (iii) increasing in the severity of the banking crisis. Even though bailouts mitigate the adverse effects of banking crises, we find that the economy is *ex ante* better off without bailouts: Accessing bailouts lowers the cost of defaults, which in turn increases the default frequency, and reduces the levels of debt, output and consumption.

**Work-in-progress.** Zach Stangebye and I have a work-in-progress project entitled “**A Quantitative Theory of the Domestic Debt Share**” [6]. Existing theories highlight different channels to explain the domestic share of government debt: (i) discrimination (assuming that governments may be inclined to default on foreign lenders but not on domestic ones), (ii) risk preferences (pointing that domestic agents –banks, pension funds, etc.– may prefer the risk profile of domestic debt), and (iii) financial repression (indicating that governments may force domestic creditors to buy domestic bonds). Our paper unifies these theories and quantifies the relative strengths of these channels. The project is built in two parts. The first part consists of a unified quantitative model of sovereign debt with domestic and foreign lenders facing portfolio problems, private investment (which may be crowded out by government debt) and an endogenous default decision. This theoretical framework is rich enough to capture the key trade offs but has been typically considered intractable due to its high dimensionality. We employ techniques from Machine Learning that allow us to capture highly non-linear dynamics in expansive state spaces while keeping memory requirements low. The algorithm works by approximating endogenous equilibrium functions using the means of Gaussian processes, which are stochastic functions. This proves to be a very efficient method for interpolating continuously and accurately between relatively few grid points. The second part is normative in nature: what is the optimal domestic share of government? And, how to implement this share? Should governments engage in financial repression? If so, how much?

Prior work has paid attention to different pieces of this problem in isolation. The need for a unified framework is clear, both from a quantitative perspective (the need to know which channel is more relevant) and also from a policy making perspective (the need to devise effective policy that incorporates general equilibrium effects).

## 4 The Interaction Between FX Reserves and Sovereign Risk

The accumulation of international reserves—official public assets that are readily available for use—is one of the most salient features of the international monetary system over the past 30 years. While prevalent across emerging markets, the increase in reserves has been led by countries with fixed exchange rates, which increased their reserves-to-GDP ratios from about 10% in the 90s, to 30% in recent years. My research on this theme asks the following questions: (i) What accounts for the striking levels of international reserves, and what is the relationship between exchange rate regimes and the accumulation of reserves?, and (ii) Does it matter how the country finances this reserve accumulation?

In “**Reserve Accumulation, Macroeconomic Stabilization, and Sovereign Risk**” [7] (currently *R&R* at the *RESTUD*) my co-author Javier Bianchi and I argue that the interaction between sovereign risk and aggregate demand amplification generates a macroeconomic-stabilization hedging role for international reserves. Using a model of endogenous sovereign default with nominal rigidities, we show how accumulating reserves allows the government to reduce the severity of future recessions. In particular, it is optimal for the government to issue debt to accumulate reserves during good times and deploy them during recessions when rolling over the debt becomes more expensive. We establish that this macro-stabilization motive can quantitatively account for the high observed levels of international reserves, a feature of the data that has proven difficult to reconcile with existing models.

To understand our argument, consider a negative shock that worsens the borrowing terms faced by a government. The optimal response for the economy is, naturally, a reduction in borrowing and consumption. In the presence of a fixed exchange rate and downward nominal wage rigidity, the reduction in consumption leads to a recession, which further deepens the contraction in consumption. The lack of exchange rate flexibility prevents the government from using monetary policy to avoid misalignments in real wages and stabilize macroeconomic fluctuations. We then show that having reserves in these states allows the government to smooth the decline in consumption and mitigate the severity of the recession ex post. From an ex ante point of view, however, the government may also choose to reduce the sovereign debt rather than accumulate reserves. What generates an incentive to accumulate both reserves and debt as a macro-stabilization policy is the fact that in states in which debt becomes more costly to roll over, having reserves allows the government to reduce the slack in the labor market. We label this channel “macro-stabilization hedging.” Moreover, by allowing the government to reduce the severity of recessions, we show that accumulating reserves can also have strong effects on debt sustainability.

Our theory provides a new perspective on the link between the exchange rate regime and reserve accumulation. Across various extensions of the baseline model, including intermediate degrees of exchange rate flexibility, commitment to reserve policies, different forms of nominal rigidities, and an explicit link between devaluations and defaults, we verify that macro-stabilization generates a strong motive for international reserve accumulation. Furthermore, we show that reserve accumulation has important welfare implications.

In “**Does It Matter How Central Banks Accumulate Reserves? Evidence from Sovereign Spreads**” [8] (currently *R&R* at the *JIE*) my co-author Federico Sturzenegger and I study whether financing the reserve accumulation with domestic or foreign debt makes a difference, in particular for the effect that reserves have on sovereign spreads. Accumulating reserves with dollar debt (i.e., assets and

liabilities with the same denomination), while providing liquidity in foreign currency, does not provide any hedge in times of distress. Domestic debt (either denominated in local currency or indexed to domestic outcomes), on the other hand, provides both hedge and liquidity, thus affecting the possibility of default and thus impacting directly on sovereign spreads.

This paper contributes in several ways to the literature. First, it provides a general model to explain why the form of reserve accumulation matters. Accumulating reserves with state contingent debt that reduces the financing needs in times of distress lowers the risk of default and leads to lower spreads (for a given level of debt). Secondly, we show these effects are found in the data: the way reserves are financed does have implications for economic outcomes. We show that accumulating reserves with domestic currency denominated liabilities does reduce spreads while using external liabilities does not. These results have been mostly absent from the literature even when they have relevant implications for policy makers. In particular, our results call into question the benefits of programs of reserves strengthening through external debt such as those typically implemented by multilateral organizations.

## 5 Other Issues

### 5.1 Global factors

In “**Interest Rate Uncertainty and Sovereign Default Risks**” [9] (forthcoming in the *JIE* and co-authored with Alok Johri and Shahed Khan) we try to close the gap between a large body of empirical literature highlighting the role of global factors in emerging economies on the one hand, and the sovereign default literature, on the other hand, which typically emphasizes the role of domestic factors with little attention to the global interlinkages highlighted by the empirical work. We develop an equilibrium model of sovereign default to study the relationship between endogenous country spreads and movements in both the level and the volatility of the world interest rate. To do so, we introduce stochastic volatility into the process of the world interest rate in an otherwise standard quantitative model of long-term sovereign debt. Time variation in the world interest rate interacts with default incentives and its effect on borrowing and sovereign spreads is state contingent. We find that the change in spread is on average 1.4 times the increase in the world interest rate when volatility is at its mean. This effect is similar to the one found in the empirical literature. This ‘slope’ increases to 6.4 when volatility state is high and falls to 0.8 when volatility is low. Not surprisingly, higher debt makes the spread response to the world interest rate stronger.

In our model, the common process for the world interest rate acts as a global factor with the potential to generate international co-movement in sovereign yields. We find that when two economies (with income process as correlated as in the data) face a constant world interest rate, their sovereign yields display a low correlation (0.17 and insignificant). However, if they face a common time-varying process for the world interest rate the co-movement between their sovereign yields increases significantly: the correlation is now 0.40 and significant. This is close to the observed mean correlation observed in the data (0.53).



## 5.2 Political economy and geopolitical considerations

In “**Sovereign Spreads and the Political Leaning of Nations**” [10] (co-authored with Johnny Cotoc and Alok Johri) we combine international data on sovereign bond yields with macroeconomic indicators and political variables to show that nations that have a higher propensity to elect left wing governments pay higher spreads on their government debt when averaged over more than four decades. These nations also face more volatile sovereign spreads. We then build a quantitative sovereign default model with long term debt and elections that lead to political turnover between two policymakers. These two policymakers differ in the political support gained from public expenditure: consistent with the data, the left policymaker gains more from public spending than the right. We calibrate this model to our international data and then use it to generate simulated economies that differ in their propensity to elect the left policymaker. The model delivers the key regularities found in the data - the economy with a higher propensity to elect the left faces higher and more volatile spreads, and it also features a more procyclical fiscal policy. A higher left-propensity occurs when the probability of winning reelection is more responsive to changes in the share of public spending. This increased responsiveness imposes a large political cost on governments that wish to repay debt in bad times by engaging in fiscal austerity measures. In turn, this cost encourages default and discourages fiscal austerity while increasing the likelihood of electing left policymakers. We show that the high level and volatility of sovereign spreads faced by the economy with a higher left-propensity lead to substantial welfare losses.

In the paper “**On Wars, Sanctions and Sovereign Default**” [11] (co-authored with Javier Bianchi) we present a simple model to think about the implications of restrictions on the use of international reserves as economic sanctions, a measure recently adopted to punish Russia following the invasion of Ukraine.<sup>1</sup> We find that soft restrictions come at no cost for the sanctioning country—they restrict resources available to the sanctioned country without negative consequences for the sanctioning country. However, a complete freezing of reserves can trigger a default by the sanctioned country and generate losses for the sanctioning country. Even though the decision to default is an optimal response by the sanctioned country, we show that a complete freezing of reserves may be optimal when there are geopolitical externalities during the war period.

## 5.3 “Hidden” debts

A new and fascinating new theme in my research agenda is the one of “hidden” debts, or more generally, the effect of opaque debt markets. I have two projects at relatively early stages.

In “**Borrowing in the Shadow of China**” [12] (joint work with Illenin Kondo and Astghik Mkhitarian) we are motivated by emerging economies’ debt to China which is large, non-marketable, and opaque. We study the impact that such borrowing from China (which is almost completely official debt) has on the equilibrium quantities and prices for marketable sovereign debt. We do so by using a standard sovereign debt model with long-term debt augmented with subsidized Chinese loans that are subject to rollover risk. We find that following a positive inflow from China the model economy chooses to re-balance its debt portfolio by deleveraging from market debt. In the process it pays lower

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<sup>1</sup>A short version of this paper is slated to appear in the *AEA P&P* (May 2023).

spreads and faces less volatile consumption. On the other hand, when facing a capital outflow vis-a-vis China, the economy taps international debt markets, levers up on defaultable market debt, and ends up paying higher and more volatile spreads in equilibrium. These model predictions are consistent with our panel-data evidence from emerging and low-income economies. Finally, we use the model to discuss the welfare gains from having access to Chinese loans and find that they are positive but smaller when default risk is material.

In a brand new project, which is tentatively entitled **“Hidden Debt Revelations”** [13] (co-authored with Sebastian Horn, David Mihalyi, and Philipp Nickol), we quantify the magnitude, characteristics and timing of hidden debt by tracking ex-post data revisions across a comprehensive new database of more than forty vintages of the World Bank’s debt statistics. In a sample of 140 countries and for 50 years of debt data, we establish three new stylized facts about hidden debt: (i) Hidden debt is large and common. (ii) Hidden debt afflicts all types of debtor countries and is most severe for bilateral and non-bond private creditors. (iii) Hidden debt builds up during boom years, and tends to be revealed in bad times, resulting in further bad news. Our plan is to then write a quantitative theory that can account for these stylized facts and to use this model to quantify the effect that uncertainty about debt revelations has on equilibrium market prices and quantities (issuances).

## 5.4 Detour

In a slight departure from my main research agenda, I also have a paper on the effects of trade reforms on firm productivity: **“Trade Liberalization and Firm Productivity: Estimation Methods Matter”** [14] (with John Kealy and Pau Pujolas, published in *Economic Inquiry* in 2019). In this paper we contribute to a large literature studying the effects of trade reforms on firm productivity. In particular, we show that the relationship between trade liberalization and firm productivity is sensitive to the method used to estimate the production function. We estimate the productivity of Colombian manufacturing plants using the three most common methods and come to surprisingly different conclusions about firm productivity growth after the trade liberalization. Results from a growth decomposition exercise and from a quantile regression model reinforce the dissimilarity of results across methods. Even though this paper is not specifically on sovereign debt, it does relate to my broader agenda on international economics and the effects of public policy (in this case trade policy) on the real economy.



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