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Sudden stops, limited enforcement, and optimal reserves



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ABSTRACT

Using a limited-enforcement model in which a sovereign government decides jointly on external debt and foreign reserves, we quantitatively determine the optimal levels of reserves and external debt. When reserves are effective in reducing the probability of a sudden stop, the model can generate the reserves-to-debt ratio observed recently in developing countries. The optimal level of reserves is increasing in the country's fundamental vulnerability to sudden stops, the effectiveness of reserves in reducing the probability of a sudden stop, the output costs of crises, and risk aversion.

1. Introduction

There has been a dramatic increase in reserve accumulation by developing countries since the 1990s. Fig. 1-(a) shows the mean ratio of international reserves to GDP for 34 developing countries from 1980.¹ Mean reserves rose from below 10 percent of GDP before 1990 to almost 25 percent of GDP in 2010. The increase is more dramatic if reserves are compared with external debt. As shown in Fig. 1-(b), the mean reserves to external debt ratio has risen rapidly and has recently exceeded 1. The Greenspan-Guidotti rule, the most widely used standard of reserve adequacy, states that a country's reserves should fully cover total short-term external debt. The mean reserves/short-term external debt ratio has even exceeded 2.

It is often argued that developing countries accumulate international reserves to insure against sudden stops, which are characterized by a sudden loss of access to the international capital market and a collapse of domestic output. Recent empirical literature has found that reserves play a role both in mitigating the costs of a sudden stop and in preventing a sudden stop crisis.² This study quantifies the level of reserves that can be justified as insurance against sudden stops, taking into account the benefits of reserves in reducing both the cost and the likelihood of a sudden stop.

We construct a dynamic stochastic general equilibrium model of a small-open economy that issues foreign bonds and saves in the form of reserve assets. The economy has a willingness-to-pay problem for its sovereign debt and is hit by sudden-stop shocks. The probability of a sudden stop depends negatively on the country's reserves-to-debt ratio. In a sudden-stop episode or in a penalty period

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¹ The sample countries are Argentina, Bolivia, Botswana, Brazil, Bulgaria, Chile, China, Colombia, Costa Rica, Czech Republic, Dominican Republic, Ecuador, Egypt, El Salvador, Guatemala, Honduras, Hungary, Jamaica, Jordan, Korea, Malaysia, Mexico, Morocco, Paraguay, Peru, Philippines, Poland, Romania, South Africa, Sri Lanka, Thailand, Tunisia, Turkey, and Uruguay.

² De Gregorio and Lee (2003) show that reserves reduce costs of crises. Berg, Borensztein, and Pattillo (2005), Bussière and Mulder (1999), Cavallo and Frankel (2008), Comelli (2014), Frankel and Saravelos (2012), García and Soto (2004), Goldman Sachs (2013), Gourinchas and Obstfeld (2012), and Tornell (1998) show that reserves significantly reduce the likelihood of a sudden stop. In Calvo et al. (2012), reserves reduce both the cost and the likelihood of a sudden stop.

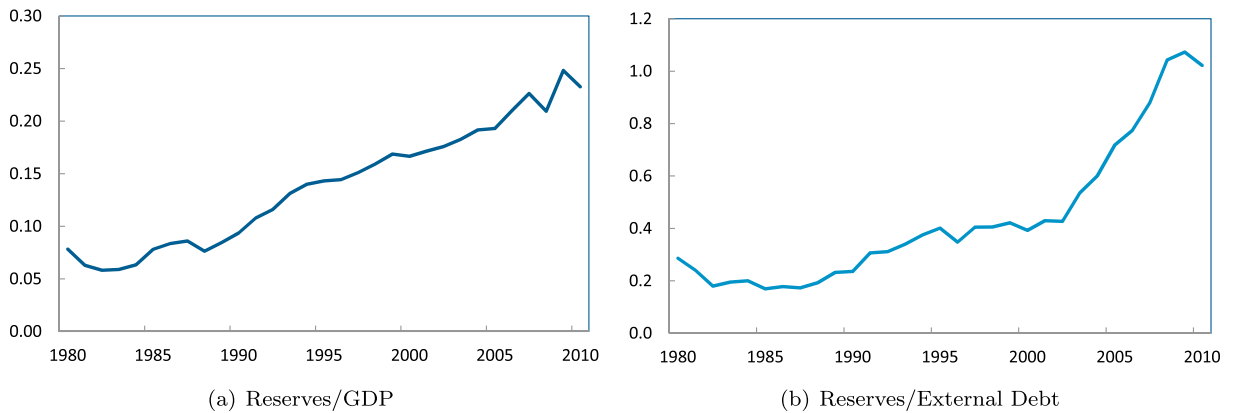


Fig. 1. Accumulation of international reserves in developing countries.

after a default, the country cannot issue foreign bonds and experiences a drop in domestic output, but it can still trade reserve assets. We calibrate the model to a sample of developing countries to quantify the optimal levels of debt and reserves. When reserves are effective in reducing the probability of a sudden stop, the model is able to generate the reserves-to-debt ratio observed recently in developing countries even though the levels of reserves and external debt in developing countries are not matched. The model predicts that the optimal level of reserves is increasing in the country's fundamental vulnerability to sudden stops, the effectiveness of reserves in reducing the probability of a sudden stop, the output costs of crises, and risk aversion.

Our study has several differences from existing studies that quantify the level of optimal reserves as insurance against sudden stops. First, many existing works, such as [Jeanne and Rancière \(2011\)](#), [Aizenman and Lee \(2007\)](#), [Caballero and Panageas \(2008\)](#), and [Lee \(2004\)](#), take a country's external debt as given, then derive the optimal levels of reserves. They set aside the joint decision of holding sovereign debt and reserves. However, external debt and reserves are determined jointly by a sovereign government. In our model, the representative agent determines both external debt and reserves endogenously by intertemporal optimization. Second, [Durdū et al. \(2009\)](#) and [Mendoza \(2010\)](#) treat less outstanding debt and more reserves as perfect substitutes, and focus on optimal levels of net foreign assets. However, less debt and more reserves are not substitutes because countries maintain large holdings of external debt and reserves at the same time. In our model, external debt and reserves are modeled separately and have their own independent roles. Third, most existing works abstract from the default risk of sovereign debt.³ Our model incorporates default risk which is an important consideration in the analysis of sovereign debt and reserves.

In a model with default risk of sovereign debt a la [Eaton and Gersovitz \(1981\)](#), [Alfaro and Kanczuk \(2009\)](#) find that the optimal policy is not to hold reserves at all. In these limited-enforcement models, additional reserves only make default less costly and, thus, tend to reduce sustainable debt levels. They find that optimal reserves are zero even though reserves reduce the output cost associated with a sudden stop. We show that, with an additional benefit of reserves in reducing the probability of a sudden stop, larger reserves no longer reduce the borrowing limit, and thus the model can explain the joint accumulation of debt and reserves. [Bianchi, Carlos Hatchondo, and Martinez \(2012\)](#) consider this endogenous sudden stop risk in a model of limited enforcement, but they emphasize the role of long-term debt, while we show that endogenous sudden stop risk enables the model to generate the reserves-to-debt ratio in line with observed data without long-term debt.

The remainder of the paper is organized as follows. Section 2 presents the model. In section 3, we conduct a quantitative analysis. Section 4 investigates how the results change as the model parameters vary, and compares the model predictions with the data. We conclude the paper in section 5.

2. Model

A small-open endowment economy borrows funds from foreign creditors by issuing one-period, non-contingent discount bonds (B). The country can also set aside some resources as reserves (A) which earn a risk-free return. The country receives stochastic income shocks (y), which follow a Markov process with transition function $f(y', y)$. The economy is also subject to sudden-stop shocks. In a sudden stop, the country cannot borrow and suffers an income loss. External debt is not enforceable. Thus the country may choose to default on its external debt. If it defaults, the country is excluded from the international credit market and suffers an income loss. The country can use reserves as a buffer to smooth consumption, even when it cannot issue new debt.

At the beginning of each period, the country learns the income and sudden stop shocks, and decides whether to default on its outstanding debt.

$$W(B, A, y, s) = \max_{d \in \{0,1\}} \{ (1-d)W^R(B, A, y, s) + dW^D(A, y, s) \}, \quad (1)$$

³ [Alfaro and Kanczuk \(2009\)](#) and [Bianchi et al. \(2012\)](#) are notable exceptions.

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