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How well do we understand sovereign debt crisis? Evidence from Latin America*

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Abstract

In recent years, the number of theoretical models on sovereign default exploded. I take a step back and investigate how good our current theoretical understanding of real world sovereign debt crisis really is. This is done by deriving implications that are hard wired into our models and comparing the evolution of nearly 20 sovereign debt crises in Latin America with them. I find that the available models capture aspects of virtually all crises, yet there are only a few crisis that are fully consistent with the available models.

JEL Codes: E44, E65, F34, H63

Keywords: Sovereign Default, Latin America, Case Study, Tequila Crisis

1 Motivation and Summary

How good is our understanding of the pattern we observe in sovereign debt crisis? A brief look into the literature reveals a huge number of empirical works investigating the determinants of such crisis. The vast majority of these works takes the bird's eye perspective of panel regressions with annual data, just a scant number of works takes a frog's perspective and looks at the detailed evolution of individual debt crisis. The major example of the latter kind of works is Sturzenegger and Zettelmeyer (2007), less known and voluminous examples are Larraín and Velasco (1990) and Damill et al. (2005). This paper is of the latter kind too and studies an even larger number of sovereign debt crises than Sturzenegger and Zettelmeyer, albeit only in Latin America. It poses a simple, yet hitherto seemingly overlooked question: Is

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the evolution of real world sovereign debt crisis consistent with predictions that are hard-wired into the models we use to describe them?

Following the business cycle literature, the modern literature on sovereign default models has adopted the practice to judge a model solely via its ability to replicate empirical facts, which are given as observed correlations in case of the sovereign default literature. This approach seems to have lead some researchers to more or less ignore what their model can by its very construction do and what not. This seems to be the case for the rise and fall of Aguiar and Gopinath (2006). Hatchondo et al. (2010) have shown that an outstanding result of Aguiar and Gopinath (that their model is able to replicate the negative correlation between interest rate spread and trade balance in Argentina as measured by the authors¹) vanishes if accurate solution methods are used. However, as expounded in Ludwig (2013b), a negative correlation is also at odds with the very way the standard neoclassical model used by them is constructed.²

Here, I shall discuss broader implications for empirically observable variables imposed by the standard neoclassical model, which builds on the seminal work of Eaton and Gersovitz (1981), and other available models. The evolution of sovereign debt crisis in Latin America is then compared with these implications. I find that a fair number of crisis is captured by an extension of the standard model that allows for contagion. The sole crisis that is fully consistent with the standard model without extensions is Argentina's default in late 2001/2002, which happens to be main empirical benchmark chosen in the literature. Furthermore, I find that there is a number of crises that are well beyond the reach of any available model.

The rest of this paper is structured as follows: In the next section, I present an overview of the available models, followed by a derivation of their implications and explanatory limitations with respect to data of actual debt crisis. These ought to be compared with sovereign debt crises. To do so, I present an algorithm that detects irregularities linked to debt crisis in sovereign debt spreads. With a list of crisis on hand, I conduct the review, which is followed by a brief conclusion.

¹Neumeyer and Perri (2005) and others, including myself, measured a positive correlation.

²The argument is, in essence, that in such a model, the trade balance is an exact mirror image of government's resource absorption. If a government in the model issues a lot of new external debt, the economy absorbs resources from abroad, i.e. its trade balance is negative and vice versa. Now, if the spread increases, viz the price of newly issued debt falls, a government will in equilibrium not be willing or able to compensate this loss by an even larger debt issue. The game theoretic reason behind this is identical to proposition 2 of Arellano (2008). Thus, spread increases will lead to a smaller resource inflow from abroad, i.e. the trade balance will improve.

2 Theory

2.1 An Overview

This study is limited to models that explicitly seek to model a sovereign default. Therefore, it does not consider the ability of political economy models of sovereign debt as Alesina and Tabellini (1990) to generate realistic debt dynamics and debt crisis. Out of the available sovereign default models, I shall consider only models with a large / infinite horizon that are build to generate a recurrent sequence of sovereign borrowing and debt repayment. Therefore, I do neither consider the model of Eaton (1996), since his stochastic model is a two period model, nor the influential work of Bulow and Rogoff (1989b) because in their work, the government borrows once a large amount and pays down its debt over an extended period of time.

As mentioned above, the model with the greatest relevance for current research is the one by Eaton and Gersovitz (1981). There and in the host of models building on it, government debt emerges due to consumption smoothing for private households and due to differences in time preferences between domestic households and foreign lenders.³ The government evaluates whether the expected utility of repaying its debt exceeds the expected utility of defaulting and bearing the associated negative consequences. A government's borrowing cost are determined by its default probability, which is the probability that the realization of the next innovation moves the economy of the government into regions of the state space where the government finds a default preferable.⁴ The pioneering quantitative implementations of this model were done by Aguiar and Gopinath (2006) and Arellano (2008) and have been since extended in various directions.

In contrast to Eaton and Gersovitz, Cole and Kehoe (2000) built a model in which, by assumption, a region in the state space exists where financial markets are prone to sudden panics (modeled by a sunspot variable). Such a panic induces a self fulfilling debt crisis: Lenders hesitate to lend more resources to the government, which deprives it from the benefits of capital market access and makes a default preferable. Thus, in both approaches the government repudiates on its debt since it may well have paid down the full amount but found a default preferable. Grossman and van Huyck (1988) develop a model where a government may be forced to

³All works in the literature use a stationary framework, which rules out a possible third rationale for sovereign borrowing: if output grows, government debt can be used to put forward consumption.

⁴The work of Kletzer and Wright (2000) can be viewed as a confirmation that the basic results of models in the Eaton and Gersovitz tradition are robust to changes in the underlying game theoretic setup. Kletzer and Wright show that positive levels of debt can exist in equilibrium even if renegotiation is possible and the only penalty for defaulting is an exclusion from loans (i.e. there is no output penalty as in most works in the tradition).

default, it has no choice: With a small probability, the government may have to endure a large negative income shock that destroys its ability to honor its debt even if it is willing to. Therefore, lenders see such a default as excusable and continue to lend to the government after the default event. The strand of literature following Uribe (2006) can be seen as an extreme version of Grossman and van Huyck's model: Uribe assumes that the government can credibly commit itself to the repayment of debt, all defaults in this kind of model are therefore akin to accidents and thus "excusable".

The willingness to default is essential in Cole and Kehoe (1995, 1997, 1998). In their models, a government and its lenders are in a sequential game in which lenders try to infer whether the government they deal with might be willing to default in the near future or not. Government's default decision is determined by a mixed strategy, implying that the exact timing of a default is random. That is, the government may well pay large risk premia for quite some time and then default without an obvious trigger.

2.2 General limitations of the available models

To my best knowledge, the literature offers only real models, which means that they are only meaningful as long as the currency itself plays no role for the decisions of lenders and the government. Furthermore, lenders are assumed to be completely unaffected by government's decisions, apart from the repayment of their loan. The most plausible real world interpretation of this setting is that lenders are located in another country. If this is the case, currency can only be no issue if a) the government maintains a perfectly credible fixed exchange rate to the country where the lenders are located or b) the government issues debt in the currency of lenders or c) lenders are able to hedge any currency risk perfectly and for free. In the real world, we see that a) and b) apply: during the 1990s, Brazil, Argentina and other countries held a fixed exchange rate to the dollar. Furthermore, emerging market governments issue a lot of their debt in rich world currencies.

This means that in all models, the "original sin" in government debt must occur: The government does not issue bonds in a currency it controls – either because its debt issues are denominated in another currency or because its local currency debt is effectively denominated in lenders' currency due to a fixed exchange rate to the latter. In both cases, the government has no option to inflate away its debt. As pointed out by Eichengreen et al. (2003), incurring the original sin does not necessarily lead to currency mismatches. If a country holds sufficiently many foreign currency reserves, honoring foreign currency payments and maintaining the fixed exchange rate is no issue, furthermore such reserves allow the country to be a "buyer of last resort" for its own debt. Thus, the models implicitly require the country to hold sufficient reserves, only then currency can be no issue given

the presence of the original sin. This means that when comparing the mechanisms proposed in the models to real world default events, one must a) only look at bonds held by foreigners and b) track the level foreign currency reserves. If the latter shrinks dramatically below the pre debt crisis level, it is highly questionable whether this particular crisis is captured by the available theoretical models.

Except for Mendoza and Yue (2012), all models in the literature present a highly stylized economy in which the government is the only agent that can draw resources from abroad and it can do so only by issuing debt. Thus, these models have some very strict implications, like a correlation of -1 between the balance of trade and the amount of new debt issues minus the repayment of old debt or a correlation of 1 between primary surplus and the balance of trade. But since this sparse modeling is so common in the literature, it makes little sense to compare and judge the models on the ground of such implications. Therefore, my focus of interest lies on the interaction of variables for which the models' implications differ substantially. This is the level of debt, output and the spread. I shall also track the primary surplus since it is often considered in policy debates.

2.3 A baseline Eaton and Gersovitz model

Again except for Mendoza and Yue (2012), the economy in sovereign default models only consists of private households, receiving a stochastic endowment and a government which maximizes household's consumption via its debt issues and debt repayment decisions. If the endowment of households fluctuates around a constant level, the government can only do two things for this purpose: It can smooth out fluctuations in endowment and it can shift consumption in time if the domestic risk free interest rate implied by the time preference of households and the international risk free interest rate differ.

Before comparing actual debt crisis with the implications of the aforementioned models, their heterogeneous economic setups have to be translated in a unified framework. For this purpose, I interpret the economic environments of the models as reduced forms and derive a possible structural model with taxes and government spending that can be collapsed into a reduced form similar to other models of this type.

Consider an economy inhabited by households and a government. Households' preferences are

$$U_0 = \sum_{t=0}^{\infty} \beta^t E_0[u(c_t)]$$

where $0 < \beta < 1$ is household's subjective discount factor, c_t is private consumption and $u(\cdot)$ is households' monotonously increasing and concave utility function.

Assume that output is given by

$$y_t = a_t \kappa_t k g_t^\gamma \quad (1)$$

where a_t is the stochastically fluctuating productivity of the economy, k represents the effect of private factors of production, which is assumed to be constant for simplicity, and g_t is government spending. κ_t is a parameter that allows to model an "output penalty" in case of a default. If the government honors its debt, $\kappa_t = 1$ and $\kappa_t < 1$ otherwise.

The government can finance its spendings with a proportional income tax of rate τ_t and by issuing one period discount bonds sold at the international capital market. Government's budget constraint is therefore

$$g_t + z_t B_{t-1} + (1 - z_t) \delta B_{t-1} = \tau_t y_t(z_t) + q_t z_t B_t$$

where $q_t < 1$ is the price of bonds, B_t describes the principal of bonds issued in t in terms of the consumption-capital good produced in the economy, B_{t-1} the bonds maturing in period t and $z_t \in \{0, 1\}$ describes the repayment decision of the government: $z_t = 1$ means repayment and $z_t = 0$ means default. In case of a default, the government is assumed to repay only the share $0 < \delta \leq 1$ of its debt. This share might depend on government's endowment, but has never been zero in all default events studied by Benjamin and Wright (2009).

Households' budget constraint is $c_t = y_t(1 - \tau_t)$. Inserting the production function and government's budget constraint into households' budget constraint allows to state the optimization problem of a benevolent government as

$$\max_{\{g_t, B_t, z_t\}_{t=0}^{\infty}} U_0 = \sum_{t=0}^{\infty} \beta^t E_0 [u(y_t(g_t, z_t) - g_t + q_t z_t B_t - z_t B_{t-1} - (1 - z_t) \delta B_{t-1})]$$

subject to lender's optimizing behavior encapsulated in their policy function $q_t = q(\cdot)$ and the order of events in every period:

1. The realization of a_t is revealed to the players.
2. Given $z_{t-1} = 1$, the government decides on z_t . If $z_{t-1} = 0$, nature draws whether renewed access to the capital market is granted. If access is granted (which happens with probability θ), $z_t = 1$, if not $z_t = 0$.
3. Given $z_t = 1$, the government issues new bonds for / buys bonds from lenders. After an agreement with lenders, the equilibrium bond price is q_t .
4. The government spends g_t , the economy produces, households consume.

The first order condition with respect to g_t does thus not depend on either q_{t+j} or B_{t+j} , where $j \in \mathbb{Z}$, and can be rearranged to gain the spending rule $g_t^* =$

$(\gamma\kappa_t k a_t)^{\frac{1}{1-\gamma}}$. Inserting this rule into households' consumption equation allows to collapse government's optimization problem to:

$$\begin{aligned} \max_{\{B_t, z_t\}_{t=0}^{\infty}} \quad & U_0 = \sum_{t=0}^{\infty} \beta^t \mathbb{E}_0 \left[\underbrace{(\gamma\kappa_t k a_t)^{\frac{1}{1-\gamma}}}_{\hat{y}_t(z_t)} (\gamma^{-1} - 1) + q_t z_t B_t - z_t B_{t-1} - (1 - z_t) \delta B_{t-1} \right] \\ \text{s.t.} \quad & \{q_t\}_{t=0}^{\infty} = q(\cdot) \end{aligned} \quad (2)$$

Since a_t is exogenous, $\hat{y}_t(z_t)$ is exogenous given government's default decision and thus, the reduced form implies an exogenous stochastic endowment as used elsewhere in the literature.

Lenders are assumed to be in perfect competition and to set the bond price as

$$q_t = q \left(P(z_{t+1} = 1 \mid \Omega_t) + (1 - P(z_{t+1} = 1 \mid \Omega_t)) \delta(\cdot) \right)$$

where q is the price of a risk free benchmark asset and Ω_t represents the information available to lenders when designing the contract. In Ludwig (2013b), I provide the explicit microfoundations for this rule. We see that the expected probability of repayment in the next period is the sole variable determining the bond price. For a model akin to the reduced form model just derived, Arellano (2008, proposition 1) shows that "default sets are shrinking in assets". This means that the set of output realizations for which the government will choose to default, viz the default probability, is the larger, the larger government debt or the smaller output is. The state space of models like the present only consists of output and debt due to repayment, we may therefore think on a "default region" in the state space and on q_t as describing the distance of the current state of the economy to the default region.

If an economy is close to the default region, it faces an unfavorable combination of debt output. Consider now the effect of a negative technology shock: The government will reduce its spending (optimal government spending is pro cyclical)⁵ and would prefer to issue more debt to be able to lower the tax rate for consumption smoothing. Optimal new debt B_t given $z_t = 1$ can be expressed as

$$B_t = \left(\frac{\partial q_t}{\partial B_t} \right)^{-1} \left(-\beta \frac{\partial \mathbb{E}_t[U_{t+1}]}{\partial B_t} \frac{1}{u'(c_t)} - q_t \right) \quad (3)$$

⁵Welfare maximizing anti cyclical government spending would require the government to have a technology that converts government spending into consumable output with a fluctuating marginal productivity. In times of crisis, the marginal productivity must increase relative to normal times. While it is debatable if such a technology exists for real world governments, it is hard to see how this technology can be unaffected by the level of government debt, i.e. how it can be fitted into an exogenous \hat{y}_t .

Arellano's result implies $\frac{\partial q_t}{\partial B_t} < 0$ (due to an increase in the default risk). The logic of the model implies $\frac{\partial E_t[U_{t+1}]}{\partial B_t} < 0$. This is because even in case of a default, a share of B_t has to be repaid. In equilibrium, the government will be unable to increase its debt unboundedly, therefore any increase in B_t implies at least interest payments at the expense of consumption some point in the future.

If B_{t-1} is already very large, increasing B_t nonetheless is only rational if $\frac{\partial E_t[U_{t+1}]}{\partial B_t}$ is not too small. If it is not, B_t must eventually be decreased relative to B_{t-1} . This can make a default eventually preferable to repayment since both rationales for government debt, bringing forward consumption and smoothing out technology shocks are too costly for the moment and regaining them requires a high tax rate for a number of periods.

Hypothesis 1 (Eaton and Gersovitz): *A default occurs when debt is high. So high that increasing it further substantially reduces utility in future periods. The default is induced by a negative technology / endowment shock that can not be smoothed out due to the high level of debt, which destroys the advantage of having access to the capital market.*

2.4 Extensions of the Eaton and Gersovitz model

As mentioned, Aguiar and Gopinath (2006) and Arellano (2008) provided quantitative implementations of Eaton and Gersovitz's model, which were (seemingly) quite successful in replicating properties of the Argentinean business cycle. This success prompted a host of follow-up works, of which however only a few introduce substantial extensions to the debt and / or default decision rule of the basic model. The works of D'Erasmus (2008), Benjamin and Wright (2009), Yue (2010), Mendoza and Yue (2012) and Lizarazo (2012), as well as Arellano and Ramanarayanan (2012) and Chatterjee and Eyigungor (2012), do not extend either. D'Erasmus (2008), Benjamin and Wright (2009) and Yue (2010) use standard Eaton and Gersovitz models but endogenize the share of debt repaid by the government when defaulting (the "haircut") and the duration of capital market exclusion. This affects the precise functional form of $\partial E_t[U_{t+1}] / \partial B_t$, but not the qualitative implications summarized in Hypothesis 1. D'Erasmus (2008) additionally introduces a randomly occurring misalignment of the discount factor of lenders and government. However, its function is similar to the differing domestic and international interest rate used in the rest of the literature: it motivates the existence of positive average government debt in a neoclassical model. The model of Mendoza and Yue (2012) endogenizes the output loss on default and thus again the precise functional form of $\partial E_t[U_{t+1}] / \partial B_t$, but not the qualitative implications of the Eaton and Gersovitz model. Lizarazo (2012) extends the model with risk averse lenders to gain a more volatile spread.

It is less obvious that the extension of Arellano and Ramanarayanan (2012)

and Chatterjee and Eyigungor (2012), namely bonds with different maturities, do not imply a qualitative change in government's default decision rule. To see this, follow Chatterjee and Eyigungor and suppose that a discrete number of n different maturities exists. All bonds are discount bonds, viz a bond with a maturity of 10 periods is the pledge to pay a certain amount of the consumption-capital good produced in the economy to the lender after 10 periods. The market price for this pledge is the bond price $q_t^{(10)}$. Denote the vector of bond prices as \check{q}_t and the vector of bond issues in t as \check{B}_t . Furthermore, denote the vector of bonds maturing in period t as $\check{\check{B}}_t$ and let ι denote a vector of ones. These preparations allow to denote the decision problem of a benevolent government as

$$\begin{aligned} \max_{\{z_t, \check{B}_t\}_{t=0}^{\infty}} \quad & \sum_{t=0}^{\infty} \beta^t \mathbb{E}_0 \left[u(\hat{y}_t(z_t) + z_t \check{q}'_t \check{B}_t - z_t \iota' \check{\check{B}}_t - (1 - z_t) \delta \iota' \check{\check{B}}_t) \right] \\ \text{s.t.} \quad & \{ \check{q}_t = q(\hat{y}_t(z_t), \check{B}_t, \check{\check{B}}_t) \}_{t=0}^{\infty} \end{aligned}$$

yielding the familiar first order condition

$$\frac{\partial \check{q}_t}{\partial \check{B}_t} \check{B}_t = - \frac{\partial \mathbb{E}_t[U_{t+1}]}{\partial \check{B}_t} \frac{1}{u'(c_t)} - \check{q}_t$$

Thus, the basic decision rule for the level of debt is still in place, the only difference to (3) is the dimensionality of its debt issue and the complexity of the interaction of the current debt issue decision with $\mathbb{E}_t[U_{t+1}]$. The government will also still default if the combination of debt and the current realization of output leads to low bond prices which in turn deprives the government from the advantages of capital market access. Being able to issue long term debt does not help: due to their higher lifetime default risk, long term debt is even more expensive than short term debt and can thus not counteract this effect.

Lizarazo (2009) also uses a standard Eaton and Gersovitz type model but adds risk averse lenders and considers multiple emerging economies. A default of one of these countries has a lasting effect on lenders' wealth, viz the amount of resources available to other countries. Additionally, Lizarazo assumes that investors' preferences exhibit a decreasing absolute risk aversion in wealth. This implies that lenders' decreased wealth increases the risk premium charged by them, which gives her model two channels for a contagion of debt crisis: a portfolio recomposition channel, since lenders rebalance their portfolio after a default in favor of the risk free asset, and a wealth channel, since lenders demand higher risk premia for taking any risk. She proves that an increase in the risk premium c.p. increases the set of output-debt combinations for which governments prefers to default. The intuition is simple: a larger the risk premium makes capital market access less attractive, viz makes a (temporary) capital market exclusion due to a default relatively less painful. This introduces the possibility of a contagion induced default:

Hypothesis 2 (Lizarazo (2009)): *A default can occur for exactly the same reasons as in the standard Eaton and Gersovitz model or due to contagion. Contagion implies that once a government of an emerging market, call it country A, defaulted, risk premia charged by lenders from other emerging markets increase. This can imply that some governments, which were almost sure to repay their debt before A's default, find market conditions for new debt issues worsened and thus might now prefer to default.*

Cuadra and Saprizza (2008) and Hatchondo et al. (2009) present models where parties in power rather than an everlasting government issue and default on debt. In Cuadra and Saprizza's model, two parties alternate in power and each party cares for "its" share of the population more than for the rest of the population. If party 1 is in power, it channels more resources to "its" share of the population. If party 1 loses power, the other party, call it party 2, will in turn channel more to "its" share of the population instead. This means that when party 1 computes the optimal level of debt for "its" share of the population, the future contemporaneous utility of the latter will at some point decrease because party 1 will lose its power. This makes policy makers more impatient, they will prefer to bring forward consumption for their share to counterweight the utility loss in the future. It is possible (but extremely messy) to rewrite Cuadra and Saprizza's model such that the probability of a loss in power is combined with the subjective discount factor to a smaller "effective" discount factor. In this form, their model is similar to a standard Eaton and Gersovitz type model, and thus its the default decision applies also to this model.

In contrast, Hatchondo et al. present a model where policy makers with different time preferences alternate in power. That is, the government is benevolent in principle, but assigns its own rather than household's subjective discount factor. This has a profound effect on the default risk: if a more patient policy maker comes to power after a less patient one and faces a substantial amount of debt, which was rational for the less patient, she is likely to default. The reverse is not true since the more patient policy maker will not build up as much debt. This introduces the possibility of a "political" default:

Hypothesis 3 (Hatchondo et al. (2009)): *A default can occur for exactly the same reasons as in the standard Eaton and Gersovitz model, or after a more patient policy maker comes into office, following a longer term in office of an impatient one. The patient policy maker will then find the level of debt to be a lot higher than preferred by her if she would have been in office, at the same time the prospect of a temporary capital market exclusion after a default is less painful compared to the impatient policy maker. This makes a default suddenly more likely, which is anticipated by lenders at time of the election. Therefore, the model generates increases in the*

spread at time of an election, if the current bond issue has to be repaid by a more patient government.

2.5 Other models

There are a number of models build on different paradigms than the Eaton and Gersovitz framework. A work that is still relatively close to the latter is Grossman and van Huyck (1988). Yet, the framework used by Grossman and van Huyck is in one important respect more restrictive than Eaton and Gersovitz type models: the government is prohibited to use the proceeds of new debt issues to finance consumption. The only purpose of debt is to produce endowment for the next period, which requires debt as input.⁶

This makes the usage of new debt to repay maturing debt impossible and debt dynamics much simpler than in the Eaton and Gersovitz tradition. To translate the authors' idea into the framework just developed, take the economy sketched above but assume that the government issues bonds where the interest is paid together with the principal. Furthermore, suppose that the government runs a state bank. This bank receives the proceeds of newly issued debt B_t , invests them and pays out $\omega B_t^\varpi + \frac{1}{\beta} B_t$ in the next period, where ω and ϖ are positive numbers.⁷ The existence of the state bank changes the budget constraint of the government to

$$\tau_t y_t + \omega (B_{t-1})^\varpi + \frac{1}{\beta} B_{t-1} + z_t B_t = g_t + z_t R_{t-1} B_{t-1} + (1 - z_t) \delta R_{t-1} B_{t-1} + z_t B_t$$

where $B_{t-1} = 0$ if $z_{t-1} = 0$. Since government spending is still unaffected by the level of debt, the rule for optimal government spending can still be used to express government's objective function as function of debt and government's default decision:

$$\tilde{U}_0 = \sum_{t=0}^{\infty} \beta^t E_0 \left[u(\hat{y}_t(z_t) + \omega B_{t-1}^\varpi + \frac{1}{\beta} B_{t-1} - z_t R_{t-1} B_{t-1} - (1 - z_t) \delta R_{t-1} B_{t-1}) \right]$$

The first order condition for debt issues is

$$\omega \varpi B_t^{\varpi-1} + \frac{1}{\beta} = \frac{\partial R_t}{\partial B_t} B_t + R_t - \beta \frac{\partial E_t[\tilde{U}_{t+1}]}{\partial B_t}$$

⁶While this may seem odd at a first glance and is not explained or founded in microeconomics by the authors, a small but positive output effect is quite plausible. This is because government bonds are an important ingredient to construct life insurances, pension funds and the like, and are extensively used in financial engineering as well as the pricing of complex assets. See Schinasi et al. (2001) for a detailed overview on the use of government debt and Yuan (2005) for a theoretical model highlighting the role of this asset.

⁷This functional form makes the technology of the bank consistent with the authors' assumptions, cf Grossman and van Huyck (1988, p.1090).

This condition implies that the technology of the state bank has a very strong influence on the level of debt: It motivates debt in the first place (since the government can not smooth private consumption); furthermore, if its marginal productivity is decreasing slowly in debt, the average level of debt will be high. Debt dynamics is very limited: the first order condition is essentially static, output only enters via governments expectations on future period's endowment, encapsulated in $E_t[\tilde{U}_{t+1}]$.

An excusable default in the sense of Grossman and van Huyck happens in case of a very bad realization of $\hat{y}_t(z_t)$. Except for its default decision, the government has no influence on current output. Thus, if $\hat{y}_t(1)$ happens to be very small, government's endowment is insufficient to service its debt, even if it is perfectly willing to do so. Event though the underlying assumptions are not particularly realistic, the broader idea that a government might commit itself to a specific usage of its debt proceeds in advance, depriving it from the ability to respond flexible enough to extreme shocks and thus possibly forcing it into default, does not appear to be completely unrealistic.

A "normal" default in which the government repudiates its debt can happen if a technology shock reduces government's expected endowment for more than one period. Since Grossman and van Huyck assume that lenders forget a repudiation after a number of periods, the government might then be willing to trade a temporal loss of endowment due to an exclusion from loans for a liberation from debt. However, Grossman and van Huyck are not very specific on the trigger of a repudiation, a repudiation might therefore also be triggered by various other events, like a change in expectations of the government on the "forgetfulness" of lenders.

Hypothesis 4 (Grossman and van Huyck (1988)): *Debt is not used for consumption smoothing, therefore the amount of debt is not particularly volatile. Government debt emerges because debt has positive output effects, a default is therefore accompanied by an additional contraction in output due to zero new debt.*

Probably, the most interesting hypothesis of Grossman and van Huyck is the possibility of an excusable default. This has one distinct feature: it is a "beyond design basis event", in the sense that it happens due to a very severe collapse in output and is followed a quick debt renegotiation and renewed market access of the government – because lenders know that this default was akin to an accident.

As shown in appendix A.1, the economy in Cole and Kehoe (2000) can be summarized in the objective function of a benevolent government:

$$\begin{aligned} \hat{U}_0 = & \sum_{t=0}^{\infty} \beta^t E_0 \left[(1 - \hat{\tau}) \hat{\kappa}_t (\phi \beta E_{t-1}[\hat{\kappa}_t])^{\frac{\phi}{1-\phi}} - (\phi \beta E_t[\kappa_{t+1}])^{\frac{1}{1-\phi}} \dots \right. \\ & \left. \dots + v \left(z_t q_t B_t - z_t B_{t-1} - (1 - z_t) \delta B_{t-1} + \hat{\tau} \hat{\kappa}_t (\phi \beta E_t[\kappa_{t+1}])^{\frac{\phi}{1-\phi}} \right) \right] \end{aligned} \quad (4)$$

Here, $\hat{\tau}$ is a constant tax rate, $\hat{\kappa}_t$ is similar to κ_t except that it remains below 1

as soon as $z_t = 0$ for the first time, ϕ is the parameter of the production function $f(x) = x^\phi$, in which private households place savings to produce next period's output and $v(\cdot)$ is a utility function with similar properties as $u(\cdot)$, but where utility depends on g_t rather than c_t . Private consumption is described by the term before $v(\cdot)$, i.e. Cole and Kehoe assume households to be risk neutral in private consumption.

(4) indicates that the government in Cole and Kehoe (2000) will issue new debt basically by the same rule as governments in models of the Eaton and Gersovitz tradition, viz (3). But because households appreciate government spending and are risk averse in it, the government will smooth its spending rather than private consumption. Because output is determined by expectations formed in the last period, output will adjust delayed, viz government revenue will collapse after the default event and not instantaneous as implied by the structural form derived above for models in the Eaton and Gersovitz tradition.

The unique feature of the model of Cole and Kehoe (2000) lies however in q_t . First, the authors do not consider defaults due to high debt / unfavorable output shocks by restricting their area of investigation to "low" levels of debt. A default might happen nonetheless if the government faces a sudden drop of the bond price. This may destroy the benefits of capital market access and thus may make a default preferable to a repayment without the immediate prospect of new loans.

Hypothesis 5 (Cole and Kehoe (2000)): *A default is triggered by a sudden drop in the bond price / a sudden spike in the risk premium. This is equivalent to a temporal exclusion of the government from capital markets or, at least, an dramatic increase in the cost of using the capital market. Because this increase is triggered by a sunspot variable, it must be sudden, starting from a moderate risk premium. Furthermore, Cole and Kehoe's model implies that the government uses its debt to smooth government spending. When defaulting, this ends, thus the volatility of government spending should increase after the default.*

Note that the model of Lizarazo (2009) has almost the same implications, since wealth channel contagion will lead to a sudden drop in the bond price for other emerging market debt.

To gain the economic setup of Cole and Kehoe (1995), start with the model for Grossman and van Huyck and assume $k = 0$, $\varpi = 1$, a deterministic oscillation of ω between 0 and a positive value larger than the inverse of the risk free bond price, and a given largest admissible level of debt. These changes imply that the endowment is now deterministic, making debt dynamics very simple: since debt is the only means to generate endowment and the production technology is linear, the government will borrow regularly and up to the largest admissible level.

However, the aim of Cole and Kehoe (1995) is not a realistic modeling of debt

dynamics but to model a setting in which information between lenders and the government is asymmetric: There are two types of governments, one that prefers not to default and one that does. Lenders do not know which kind of government they are interacting with but try to learn from government's behavior (limited to the decision whether to repay and, possibly, whether and how much to save and borrow). This puts lenders and the government in a sequential game. The equilibrium of the game depends critically on its environment, showing the importance of institutional assumptions as response of the critique of Bulow and Rogoff (1989a).

As pointed out in Ludwig (2013a), where I endogenize the different types of governments in a model of potentially failing reforms, this sequential game has two interesting properties: first, it implies that the knowledge of lenders about the government they deal with is not visible in the interest rate all the time. Rather, this risk enters the risk premium only towards the end of the game. Furthermore, once the risk premium is visible, a "bad" government must not default immediately. Thus, this kind of model can provide the rationale for a specific kind of default event:

Hypothesis 6 (Cole and Kehoe (1995, 1997, 1998)): *A default that arises in a sequential game as modeled by Cole and Kehoe occurs in an environment of high interest rates. The exact timing of the default is random, that is: one may well observe high interest rates for quite some time before, without any obvious trigger, the default occurs.*

3 Empirical Strategy

3.1 Country selection

This study focusses on Latin American countries for two reasons. First, in contrast to Africa, a substantial share of Latin American countries has issued publicly traded bonds. Second, in contrast to eastern Europe, about all Latin American countries are independent for at least a century and thus had time to build up debt, increasing the potential scope for sovereign debt crisis.

Since I lack a sufficiently large set of bond data for each Latin American country, I shall use spreads from the J.P. Morgan's EMBI Global index, i.e. the difference of the weighted average of yields of bonds in the J.P. Morgan Emerging Markets Bond Index for the specific country to an index of US treasury bonds as provided by J.P. Morgan. All bonds in this index make their payments in US dollars (for details on the index see Cavanagh and Long, 1999). This spread is not available for Costa Rica, Bolivia, Guatemala, Honduras, Paraguay, Cuba, Haiti, Nicaragua and Puerto Rico. The reason is that all except the latter do not have a sufficiently large number of liquid, Dollar denominated bonds.

Puerto Rico issues debt in form of US (tax exempt) municipal bonds. To my best knowledge, there is no academic research on Puerto Rico's sovereign debt; research by wealth management companies indicates that government finances of Puerto Rico exhibit various peculiarities, like a lightly regulated state bank serving as pivot for all kind of financial transactions of government entities. This implies that the precise level of sovereign debt is known to be around 100% of GDP, yet its exact level is opaque (cf Schankel, 2012, 2013). Furthermore, the spread between risky Puerto Rican bonds and risk free municipal bonds has been around 8% in the summer of 2013, which seems too small given recent emergency measures to avoid a default (see Reuters, 2013). For this reason, even though a spread for Puerto Rico can be computed, it will be excluded from the study since its government debt is issued in an institutional framework well beyond the scope of the available models.

In case of the Panama and the Dominican Republic, EMBI spread data is available, furthermore the Dominican Republic defaulted 2004 and is thus a potentially interesting case to study. However, neither its central bank nor its statistics office offers a time series for foreign currency debt in a finer sample frequency than annual. Since the level of debt is a main determinant of a government's default decision in the Eaton and Gersovitz (1981) model and also important in other models, a study without better data on debt is useless. The same is true for Panama: About all data offered by its statistics agency (there is no central bank) are available only in annual sample frequency. Therefore, I shall omit a study of the Dominican Republic and Panama.

3.2 Crisis detection

A premier difficulty for a study like the present, where "near death experiences" in which a country was close to a default but avoided it, as well as actual defaults are to be studied, is a clear distinction what a sovereign debt crisis is and what not. In section 2, I expounded that a low bond price / a high interest rate spread might deprive a government from the advantages of capital market access and might thus increase the relative advantage of a default. But what is high? If a country faced a spread of, say, 500 bps for a number of years, an increase to 700 might be manageable for the government, while a country that paid 100 bps might find itself unable to free up enough resources to serve debt yielding 700 bps.

Therefore, I shall detect sovereign debt crises not by defining some upper bound for the spread and defining times where the spread exceeds this bound as crisis. Rather, I shall detect crisis by "irregular" moves of the spread. The existence of such movements in times of crisis is an implication of the equilibrium default risk / bond price function in Eaton and Gersovitz type models: as displayed by Aguiar and Gopinath (2006, p.76 (Fig.3)) and Ludwig (2013b, p.12 (Fig.2)), they follow a logistic function in debt. This function has a large slope, the risk premium

nearly jumps from close to zero to very high values. The intuition for this is simple: government's choice on default is discrete, without insecurity on the next realization of output the default probability as used by lenders would therefore be a discrete function. The volatility of output innovations blurs this discrete jump to a logistic function.

Now, follow a country in an Eaton and Gersovitz type model into a debt crisis: It already holds a fair amount of government debt and is hit by a series of negative output shocks. Initially, the government will increase its debt to smooth consumption. As long as the economy is distant enough from the default region, this will increase the default risk and thus the bond price only slightly. After a severe shock, the amount of debt increases substantially, the economy moves close to the default region, the default risk increases dramatically and the increased spread begins to limit government's abilities to issue more debt. At this point, the economy is in a sovereign debt crisis, since its government's incentives for repayment (the prospect of consumption smoothing) are diminished due to the low bond price.

If the government manages to honor its payments nonetheless and is blessed by a positive output realization shortly after, it had a "near death experience" where it avoided a sovereign default by a narrow margin. The economy begins to move away from the default region, the spread decreases. In case the government does not manage to honor its payments, the default materializes and the spread will mirror lenders' expectations on debt renegotiations. In both cases, the time series of the spread will exhibit a jump where the default risk increased dramatically, i.e. where debt reaches a level where the slope of the logistic function increases from near zero to a large number. To detect such jumps, I use the following algorithm:

1. For each country, compute a forecast for the spread at trading day t using an AR(20) estimated on the preceding trading days. Compute and store the forecast error, the estimated variance of innovations of the particular AR and the adjusted R^2 of the estimate and repeat this for every trading day.
2. If the norm of the forecast error exceeds 2 times the average standard deviation of AR innovations for the particular country, the particular day may have exhibited a sudden move in the spread.
3. Of the candidates, I drop out all where the forecast error was computed with an AR that had an adjusted R^2 of less than 0.3.⁸
4. Of the remaining candidates, drop out all where the spread was less than 500 bps within 10 trading days after the event. This removes sudden downward moves and brief erratic movements in the spread from the candidate list.

⁸The average adjusted R^2 is between 0.8 and 0.9.

The order of the AR and other parameters were gained by calibrating the algorithm such that it detects the largest possible number of well known debt crisis and actual default events without turning out too many "non-crisis", i.e. moderate spread movements not linked to a noteworthy crisis. Using the algorithm, I find the following irregularities:

Table 1: Detected irregularities

Country	data begins	irregularities	default
Argentina	01/1994	01/2002, #	11/2001*,†
Brazil	05/1994	01–03/1995, 01–02/1999, 06–10/2002	/
Chile	06/1999	/	/
Colombia	03/1997	08–11/1998, 05–06/1999, 05/2000, 08/2002	/
El Salvador	05/2002	11/2008–02/2009	/
Ecuador	03/1995	09/1998, 08–09/2000, 10/2008–07/2009	08/1999*, 12/2008*,†
Mexico	01/1994	02–03/1995	/
Peru	04/1997	08/1998–05/1999, 06–11/2000, 04–06/2001, 06–12/2002	09/2000*
Uruguay	06/2001	07–09/2002, 03–04/2003, 11/2008	05/2003*,†
Venezuela	01/1994	01–02/1995, 08–09/1998, 09–10/2008	07/1998*

* issuer default rating (IDR) by Moody's, see Tudela et al. (2011);

† IDR by Fitch, see Needham et al. (2013, p.10).

the algorithm additionally detects and irregularity in June 2005, where some of the defaulted bonds have been removed from the EMBI index. Since the spread was above 500bps until more bonds were removed in July 2005, the algorithm does not drop out the first move.

3.3 Data

News: Contemporary news are a key ingredient for the present study. My main sources are back issues of the Economist and the New York Times archive. Additional sources are the news releases archives of the rating agencies Fitch and Moody's⁹ as well as of the International Monetary Fund. To increase the readability of the text and avoid a 10+ page reference list, I shall split my references: News sources for a specific event are not cited in the text but listed in a hypertext news reference for this work that chronologically lists and references all news events for a crisis. This reference will be available at mludwig.org. All other sources are cited the usual way.

Debt data: Displayed debt time series are debt of the central government since subordinate entities may have differing market access and default probabilities.

Fiscal data: If available, I display the central government's primary surplus, including one time revenues and spendings, since this is the clearest measure of

⁹Unfortunately, Standard & Poor's does not offer a comprehensive archive for non customers, therefore news on rating actions by Standard & Poor's are not included.

a government's amount of resources available to serve its debt. A few countries offer only the fiscal surplus, i.e. they offer no data on their spending on interest / coupon payments. Venezuela does not publish any data on government revenue.

Foreign currency reserves: Data is available on a monthly and, seldom, even on a daily basis from the respective central banks. If available, I use end of month data instead of averages.

GDP: I display the seasonally adjusted real GDP. Seasonal adjustment is done by the X12-arima method, as provided by the US census and made accessible via the Eviews interface.

Interpolation: To see the actual timing, all variables should ideally be available on a daily basis. Since this is obviously only the case for the spread, an interpolation is needed. I experimented with a large set of possible proxies for Argentinean data but found it impossible to improve the informational content of the available monthly data set. Given the smaller data sets available for most other countries, it seems unlikely that such an improvement is possible for any other country. Therefore, I use a linear interpolation to obtain daily data.

4 Crises

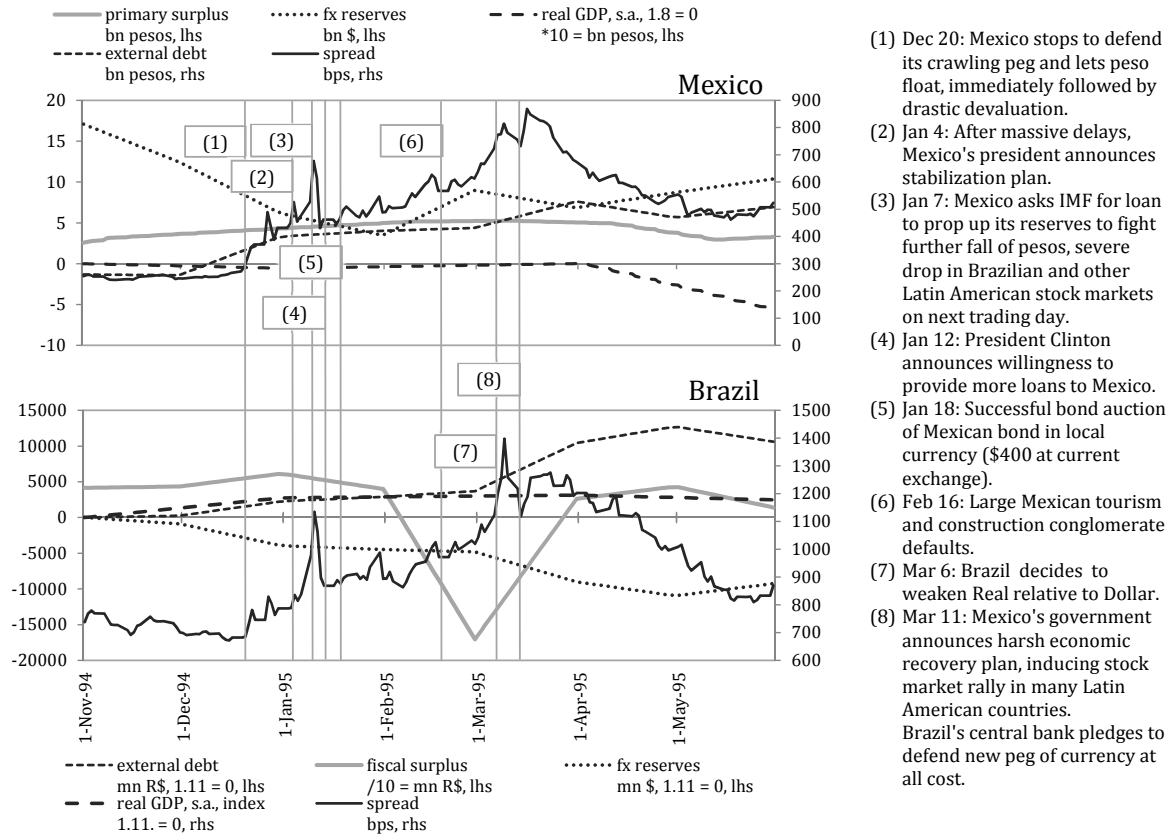
4.1 The Tequila crisis

Inspecting table 1 we see that many of the detected crisis cluster around specific dates. The earliest of these is the cluster of irregularities in the spreads of Brazil, Mexico and Venezuela from January to March 1995. Looking up contemporary news, these simultaneous irregularities can be identified as the so called Tequila crisis, which started in late December 1994 in Mexico and spread to other Latin American countries. Figure 1 on page 19 presents a visual summary of the events.

Mexico: The events provide an indication that its crisis is mainly a currency crisis. In particular, before the devaluation (event 1), Mexico halved its reserves within less than two months defending the peso. In contrast, Brazil's stock of reserves in the fall of 1994 was more than twice the size of Mexico's and decreased by 25% or \$10 bn from their peak level at the beginning of October 1994 to their temporary low at the beginning of May 1995. Roughly contemporaneous with the devaluation, Mexico's economy faltered. There are no signs of consumption smoothing via government's external debt; real GDP and external debt evolved independently. This is mainly due to the effect of the devaluation, which increased the peso value of Mexico's debt. The reading of Mexico's crisis as a currency crisis is also confirmed by the fact that the spread started increasing at the very day Mexico devalued. Since the devaluation was severe, it seems likely that without

the US bail-out (event 4), Mexico would have been unable to serve its debt before February.

Figure 1: The Tequila crisis 1994/1995



Fiscal data for Venezuela is not available for this period of time

Brazil: Similar to Mexico, Brazil' GDP was stagnant in the beginning of 1995, but due to strong growth Q3 1994, it was not in a recession. Brazil was running a moderate fiscal surplus of around 0.4 bn Real, which temporary turned to a deficit of 1.7 bn Real in February 1995. While this coincides with an increase in Brazil's spread, it is unlikely to be causal for this move for two reasons: first, since the deficit is a function of the state of the economy, which can be inferred from numerous measures, it is thus unlikely that markets were completely surprised by the figure at the end of February. That is, if this deficit would be relevant for the markets, we should see some movement in the spread before the end of February. Second, the steepest increase occurs after March 6, where Brazil changed its exchange rate band (event 7). The latter is likely to have ignited market fears that a devaluation might be the first step towards renewed hyperinflation. This is because, Brazil's fixed exchange rate was a measure to fight hyperinflation (for details see Frenkel and Rapetti, 2010), being forced to abandon it would have meant losing macroe-

conomic control. This in turn would tarnish the ability of Brazil’s government to tackle its pressing economic problems, which would curtail the abilities to serve Brazil’s sovereign debt. Yet, since its foreign currency reserves were considerable during the whole crisis, the prospect of a running out of reserves was rather distant, which makes the pace of the spread increase somewhat curious. Summing up, we see that the spread movements for Brazil have a domestic component, but this appears to play a role mainly from February to April. From December to February, the lack of domestic foundations and the close synchronization with the spread movements for Mexico indicate that Brazil was suffering from contagion.

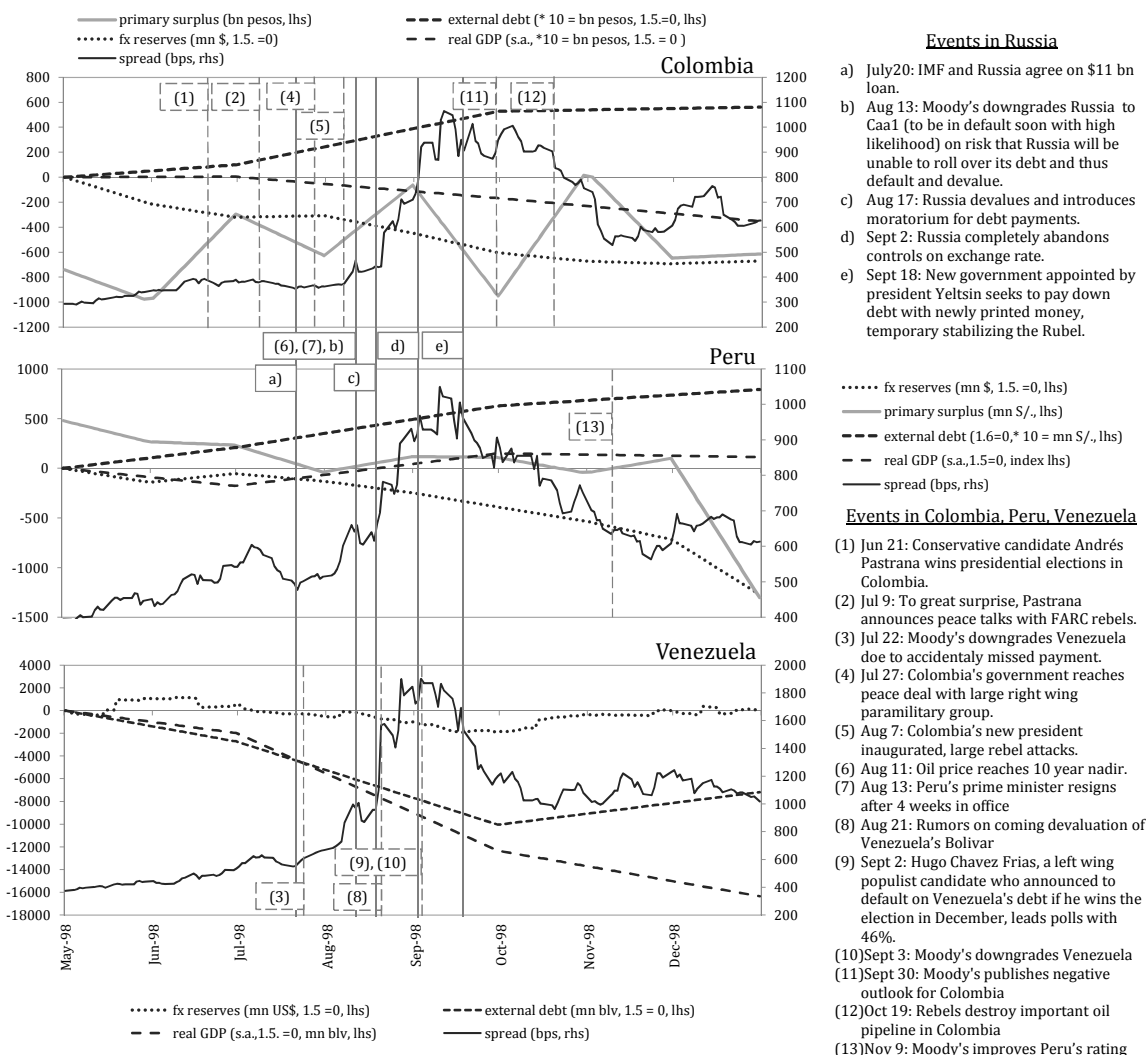
The literature offers only one model for contagion, the model of Lizarazo (2009). And indeed, hypothesis 2 appears to be consistent with Brazil’s time series at the beginning of the crisis: Given the immediate prospect of a default of Mexico, lenders expected their future wealth to shrink. This induced a portfolio rebalancing towards the save benchmark asset, leading to increased risk premia for other countries. The bail-out by the US (which could be modeled along the lines of Aguiar and Gopinath, 2006, pp. 80) shrunk the risk of a default considerably, which drove down risk premia for other countries. A reading for the renewed increase after the pacification in early January 1995 is that it reflects both a domestic component, combined with renewed contagion from Mexico, which was unable to adopt sufficiently bold policies to foster an economic recovery until early March.

In case of Mexico, the crisis has obviously little to do with the debt crisis described by the models above, a second generation currency crisis model seems to be much more appropriate (for an introduction into and overview on such models see Flood and Marion, 1999). This is bad news for the model of Cole and Kehoe (2000), since it was created with the outspoken goal to capture the Tequila crisis. But Cole and Kehoe’s approach to model a crisis as a sunspot event seems to be inconsistent with the fact that the draw down of reserves allowed all market participants to bet on the time where Mexico must give up to defend the peso, i.e. the timing of the devaluation and the ensuing crisis was far from random.

4.2 Contagion from Russia’s debt crisis

A second cluster of irregularities begins in August 1998 and partly stretches to the first months of 1999. Countries exhibiting an irregularity in this period of time are Colombia, Ecuador, Peru and Venezuela. The spread data set reveals that indeed, most Latin American countries faced a steep increase of the spread starting from the middle of August 1998, where Russia devalued and defaulted on its debt (for details on Russia see Sturzenegger and Zettelmeyer, 2007, chapter 4). Figure 2 presents a visual summary of the events in Latin American countries exhibiting irregularities in the spread.

Figure 2: Contagion from Russia in 1998



Fiscal data for Ecuador is not available for this period of time.

Peru: Here, we see no indication that the spread reflects the current state of the economy or specific local events. During the relevant period of time, I am able to find only two news on Peru's economy worth mentioning. Furthermore, there is no indication for any closeness of the economy to the default region which would justify significant upward movements of the spread: GDP was growing and debt was more or less constant. Moody's improved the rating of Peru twice in 1998, from B2 to Ba3 in March and from Ba3 to Baa3, i.e. investment grade, in November (event 13). Furthermore, we see Peru running a primary surplus around the time of strong increases in the spread.

Colombia: In the summer of 1998, Colombia entered a downturn after a few quarters of robust growth, which, as we would expect a consumption smoothing

government to do, is mirrored by large primary deficits and growing debt. However, the absence of rating actions and contemporary news stories on Colombia's economy indicates that this development has not been much of a concern and indeed, the spread fell in late 1998 even though Colombia was then closer to the default region than around the time of the spread increase. Contemporary news were filled with reports on attempts by the newly elected president, Andrés Pastrana, to negotiate peace with Colombia's various rebel groups to end a decades old conflict, which costed thousands of lives and left parts of the country ungovernable. This was not successful, yet the evolving failure does not appear to be a relevant driver of the spread: the spread fell after event 12, which inflicted serious economic damage and corroborated the outright failure of the peace talks.

Venezuela: Here, the increase of the spread fell into a period of a fully fledged economic collapse, between late 1997 and early 1999 Venezuela's real GDP shrank by a cumulative 10%. Yet, Venezuela's external debt was shrinking too at that time, which indicates that the economy can not have moved significantly closer to the the default region. Since about all important domestic events are contemporaneous with events in Russia, it is hard to say whether domestic events are a relevant driver for Venezuela's spread at that time. For example event 9, news on a poll that suggest that the next election might turn out a president willing to default on Venezuela's sovereign debt, came at the very day Russia abandoned its exchange rate controls completely, which was seen as a sign of Russia's crisis worsening. Therefore, the increase of the spread between events 8 and 9 can not be confidently attributed to the emergence of the possibility of such a political default.

Thus, there is no conclusive evidence that the displayed moves in the spread are driven by domestic events. Instead, we see drastic increases in the spread after event c, Russia's default. Paradoxically, the spread for Colombia reacted with a delay of one day, for which I found no explanation.

Yet, also the events in Russia do not seem to be linked to the development of the spread of the depicted countries in a simple manner. In all countries, dramatic increases in the spread occurred after event c, Russia's default. Except for Colombia, the spread declined after event e. In between these events, there is no clear correspondence; in neither country the peak of the spread appears to have an obvious correspondence with events in Russia. Yet, I view the small number of domestic events as indication that the depicted moves in the spread were mainly driven by market concerns that these countries might head into similar struggles as Russia.

In contrast to Brazil in 1995, applying hypothesis 2 to explain the present crisis is not easy: Lizarazo models lenders wealth in each period as consisting of the returns from previous investments plus a constant exogenous component. If a default happens, lenders wealth shrinks and due to the decreasing absolute risk

aversion in wealth, the bond price of all other countries will fall. To make it rise again quickly (which is necessary to generate the observed quick return of the spread to its old level), this loss must immediately be filled up. But because the exogenous component is constant, the loss can only be filled up by a reduced withdrawal of lenders for consumption. Since lenders are impatient in consumption and thus will not prefer to reduce consumption by a large margin, this will certainly take many periods. This means that Lizarazo's model is entirely able to replicate the observed brisk increase in the spread, but unable to generate the observed decline of the spread weeks after the default.

4.3 Irregularities in the summer of 2002

In contrast to other clusters in this study, the cluster of irregularities in 2002 is not marked by their closely synchronized occurrence. Yet, strong movements of spreads in the absence of noteworthy domestic events indicate that contagion must have played an important role here too. And indeed, the election in Brazil and, to a lesser extent, the turmoil in Uruguay do appear to have generated spread movements in other Latin American countries. Figure 3 on page 25 presents a visual summary for Brazil, Colombia and Peru. Due to the much longer duration of its crisis, Uruguay is considered separately in the next section.

Brazil: Brazil's economic performance in 2002 was robust with substantial growth in real GDP. Its currency was floating freely and at the time constantly depreciating. Brazil's relatively stable foreign currency reserves indicate that Brazil did not counteract this. We see that Brazil more than doubled its external debt in a brief period of time, from about 100 bn Reais in February 2002 to nearly 210 bn Reais in September 2002. Since Brazil is only publishing the value of its external sovereign debt in domestic currency, it is hard to say whether the observed rapid increase in its external debt is only due to its devaluation, yet it seems likely that the latter did play a very important role. Whatever the reason, we observe the strongest spread movements after event ♣ and c, which are in no simple way related to the increase of external debt.

Thus, GDP and debt were growing and spread movements do not seem to relate to debt dynamics. Therefore, it is hard to reconcile the overall evolution of Brazil's economy with a basic Eaton and Gersovitz framework. Since no default occurred, hypothesis 6 can not be applied, which means that only two hypotheses remain: hypothesis 3, that is Hatchondo et al.'s model of the possibility of a "political" default and hypotheses 5, the model of Cole and Kehoe (2000) with its erratic market panics. However, we see a close synchronization between spread and the prospect of candidate Lula da Silva, who threatened to default on Brazil's debt in previous election campaigns. This leaves us with Hatchondo et al.'s model as

only alternative. And indeed, the crisis is roughly consistent with the model: The increase of the spread in early June coincides with an increase in the growth rate of foreign currency debt and a severe drop Brazil's fiscal surplus. While this is not necessarily problematic if the current policy maker stays in office, a possible change in office to a policy maker with a higher patience (Lula da Silva) introduced the risk that with the new policy maker, the economy moves closer to the default region. In the days before event b, this possibility seems to have been realized by the markets and appears to have become near certain after event c. After c, we see a stabilization of fiscal surplus and a modest intermediate reduction of foreign currency debt, which coincides with a drop of the spread and is consistent with the Eaton and Gersovitz framework that also lies behind hypothesis 3: Since da Silva's chances to be elected can have not changed much at this time, this can be interpreted as a small positive output shock that moved the economy away from the default region, followed by a minor negative shock shortly before the election. Note however that there is a major problem with the required default tread of Lula da Silva, which will be expounded at the end of this section.

Peru: In the summer of 2002, Peru's political system was still recovering from the crisis following president Alberto Fujimori's dubious attempts to secure a third term in office (see section 4.5.5 for details). After a brief recession at the beginning of 2001, Peru's real GDP grew until the summer of 2002. Yet, after decreases in 2001, external debt was rising again and the government was only partially running primary surpluses. The spread increase in early June occurred at a time when debt was flat and GDP rising, which confirms the interpretation we may already have reached by observing the timing: this increase is linked to event ♣.

As one would expect in an Eaton and Gersovitz type model, the spread increase in late July coincides with a worsening budget, yet the exact timing of the spread increases (namely event c) suggests that events in Brazil were at least as important as domestic events.

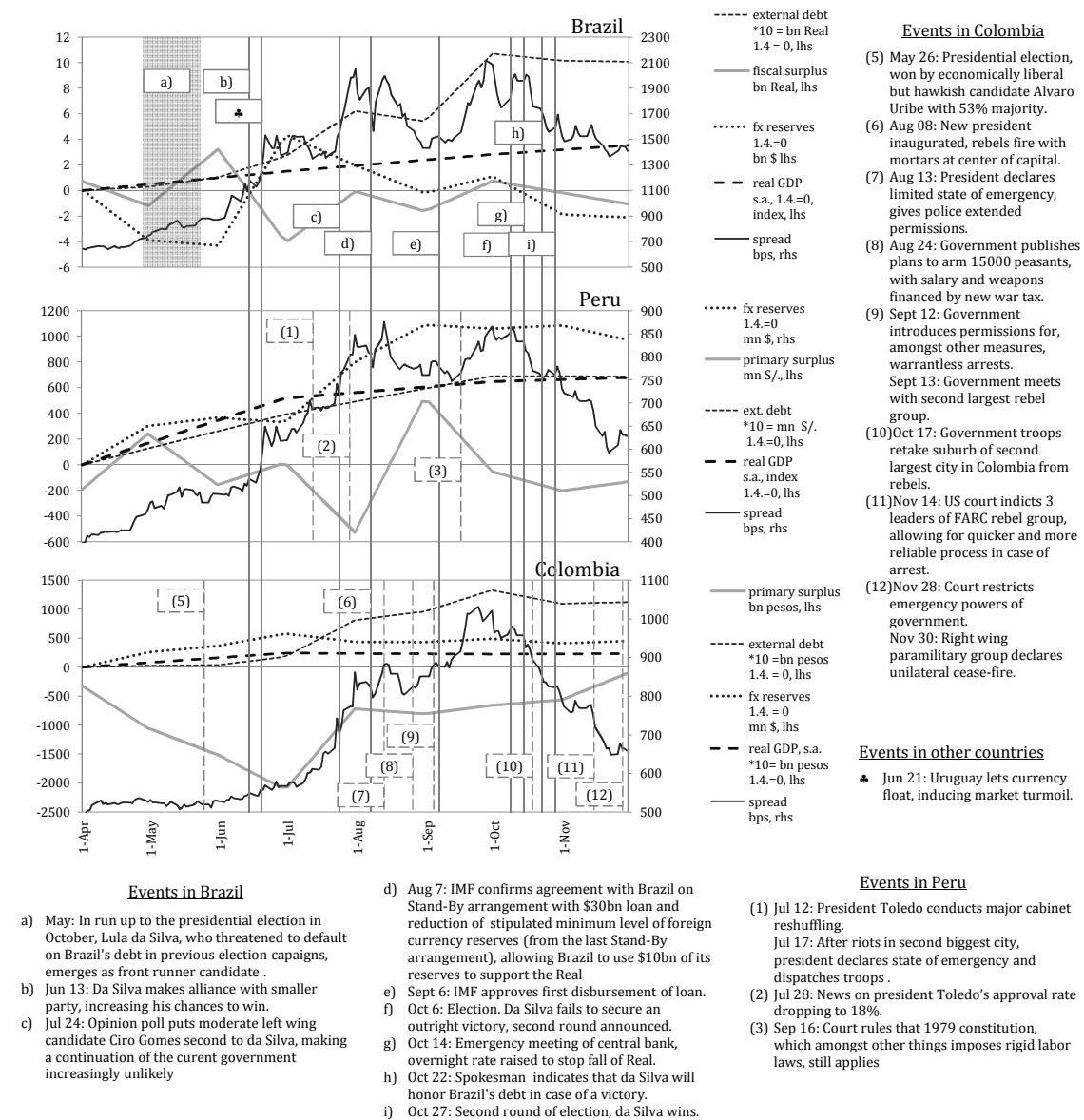
Colombia: While Peru was already recovering from a severe crisis, Colombia was on the brink on becoming a failed state, if the then newly elected president Álvaro Uribe would not have been successful. Colombia faced an intensifying conflict with rebel groups and a long phase of weak economic performance. In early 2002, its economy was recovering from a double dip recession between 1999 and 2001 (see section 4.5.3 for some further details on this). During 2002, Colombia's recovery was bumpy, it gained pace only in 2003. During the first quarters of 2002, the Colombian Peso depreciated by about 25% relative to the dollar, which substantially increased the value of Colombia's external debt in domestic currency. Its economic situation moderated in Q4 2002, which coincides with a decreasing spread.

Thus, in contrast the Peru and Brazil, the movement of the spread roughly

corresponds with a phase of increased fiscal stress of the government, due to a ballooning value of external debt. Event though changes in the value of existing debt are not included in existing Eaton and Gersovitz type models, the evolution of time series seems to be consistent with such a model, where an exogenous force changed the value of outstanding debt. This moves the economy closer to the default region and indeed, the spread exhibits roughly the same pattern as the exchange rate induced upward movement of debt does.

However, we also see a brisk spread movement around event c, at the time when Brazil's crisis exacerbated. This indicates that the events in Brazil also seemed to play a role.

Figure 3: Irregularities in the summer of 2002



Thus, we saw that hypothesis 3 captures Brazil’s crisis in 2002 relatively well. Hypothesis 2 can be used to explain the evolution of time series for Peru and, to a lesser extent, for Colombia. The latter additionally seems to have suffered from a crisis linked to its exchange rate, which is out of the scope of the available models.

Yet, there is a major issue with the application of hypotheses 3 and 2: Brazil did not default. To generate contagion, Lizarazo’ model requires substantial expected losses in the next period and to generate a spread increase, Hatchondo et al.’s model requires lenders to rationally expect a more patient next government. Thus, applying both models requires lenders to believe firmly that Da Silva’s will default in case he is elected. But this is hard to reconcile with full rationality since rational lenders could read in the Economist¹⁰ that Da Silva assured business leaders already mid May 2002 that he changed and that his policy will be ”social democratic” in the sense that he supports business and free trade and plans to honor all of Brazil’s debt. He held true to this after the election, which makes the required believe of lenders rather outlandish.

4.4 Irregularities in the fall of 2008

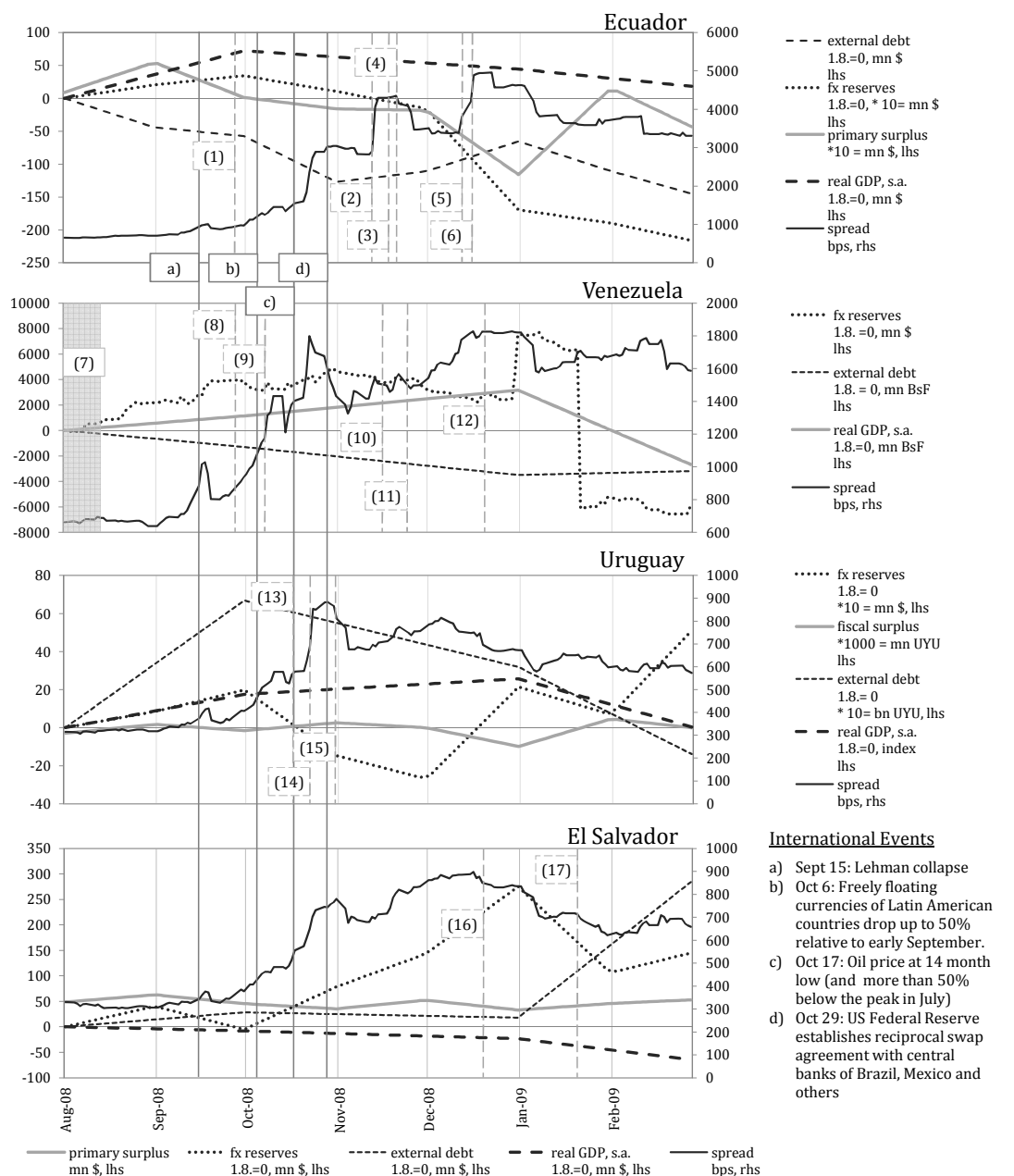
While the aforementioned crises are at least partly known in the literature, the cluster of irregularities in the fall of 2008 has, to my best knowledge, not been described and studied yet. We see irregularities in October and / or November 2008 in Ecuador, El Salvador, Uruguay and Venezuela. This is not surprising for Ecuador: After delays in a \$30 bn interest payment in November 2008, Ecuador’s president Rafael Correa announced a default on two global bonds in December 2008. Thus, there are two possible rationales for this cluster: it might be linked to the financial turmoil following Lehman Brother’s collapse in September 2008, but it might also be due to a contagion from Ecuador. Figure 4 on page 27 presents a visual summary of the events.

Ecuador: It is remarkable to see that even though its economy headed into a recession, neither the evolution of Ecuador’s sovereign debt nor of its primary surplus exhibit signs of massive financial stress before event 4. The amount of sovereign debt was continuously shrinking and in August 2008, about a month before president Correa announced an evaluation of the legitimacy of Ecuador’s sovereign debt, primary surplus was \$0.5 bn or about 6% of its external debt, which itself was around 23% of GDP.

This, together with the fact that president Correa was elected in November 2006 but made the announcement nearly two years later, just before a referendum of a new constitution, indicates that this default is inconsistent with hypothesis 3. Besides the timing of the election, the framework of Eaton and Gersovitz, on which

¹⁰ *Who’s afraid of Lula?* The Economist, May 17th – May 24th 2002.

Figure 4: Ecuador's default in 2008 and other countries exhibiting irregularities at the same time



Events for Ecuador

- (1) Sept 27: President Rafael Correa threatens to file international law suits on "illegitimate" foreign debt
Sept 29: Proposal for constitution, which gives more power to the president, approved by voters
- (2) Nov 14: After announcement of government that it will not honor coupon payment, Moody's downgrades Ecuador to quasi-default (Caa1)
- (3) Nov 17: Coupon payments not honored.
- (4) Nov 20: Report on legitimacy of debt finds that three contracts worth \$3.9 bn were negotiated by malefasant officials
- (5) Dec 13: Debt default
- (6) Dec 16: Downgrade by Moody's to default (Ca)

Events for Venezuela

- (7) early August: Parliament approves constitutional changes that increase state influence in economy.
- (8) Sept 26: \$1 bn loan from Russia for military purchases.
- (9) Oct 6: Government announces spending cuts in face of tumbling oil revenues.
- (10) Nov 17 Government starts \$0.3 bn sovereign debt buyback to support debt price.
- (11) Nov 23 Election, opposition gains ground but Chavez stays in power.
- (12) Dec 22 Fitch downgrades Venezuela in face of declining revenues from oil.

Events for Uruguay and El Salvador

- (13) Oct 16 Uruguay' central bank states that Uruguay has \$2 bn of unused financial resources, allowing it to wait with the next auction of sovereign debt for up to two years.
- (14) Oct 24 Uruguay's central bank president Walter Cancela resigns.
- (15) Oct 30 Ruling coalition struggles to agree on new president of Uruguay's central bank, agreement takes two more weeks
- (16) Dec 22 El Salvador secures \$800 mn IMF loan.
- (17) Jan 18 Election in El Salvador, leftist party wins.

hypothesis 3 rests, requires some kind of financial stress that makes the serving of debt too painful for the new policy maker. Such stress is hard to see in case of Ecuador before event 4. We see a substantial draw down of reserves, but this followed a massive built up in the first half of 2008 from around \$3.8 bn in previous year to \$6.5 bn in late September 2008. Additionally, Ecuador has no currency to defend, since it adopted the Dollar as legal tender.

In contrast to models in the Eaton and Gersovitz framework, the model of Grossman and van Huyck (1988), viz hypotheses 4, is consistent with two aspects of this default: First, Ecuador’s sovereign debt has indeed not been particularly volatile. In the Eaton and Gersovitz framework, debt is also used for consumption smoothing and will therefore fluctuate considerably with the business cycle. Ecuador’s debt has merely fluctuated between \$9 bn and \$10 bn between the defaults in 1999 and 2008. Second, Grossman and van Huyck’s approach of modeling lenders as forgetting a default after a number of periods allows to model the reason why an exclusion from the international capital market was seemingly not frightening for Correa: only weeks after the default, Ecuador received a \$200 mn loan from Iran and fixed a \$1 bn loan for oil deal with China about 8 months later. In terms of Grossman and van Huyck’s model, this can be read as lenders forgetting the default immediately. By reducing the number of periods lenders remember a default in the model, the modeled government will default even in a relatively friendly environment since the disadvantages of a default are profoundly reduced.

One might be tempted to conclude that the substantial drop in primary surplus in the month of the default is also consistent which Grossman and van Huyck’s approach of modeling debt as being used to generate revenue for the government. However, the reason for this drop was Ecuador’s debt buyback, in which it repurchased the defaulted bonds for roughly 35% of their pre default value and is thus no evidence for a ”productive” use of Ecuador’s sovereign debt, as required by Grossman and van Huyck’s model. Therefore, while Grossman and van Huyck’s model is consistent with many aspects of Ecuador’s 2008 default, it is no fully convincing model for the latter.

El Salvador We observe an evolution of real GDP and external debt that is consistent with consumption smoothing: in the second half of 2008, El Salvador’s GDP was flat and its external debt was growing with a moderate pace. At the beginning of 2009, it was hit by a substantial shock that decreased its real GDP by an annualized 10%, which is mirrored by an increase in debt. Yet, the spread increased months before this, which indicates that the spread has been mainly driven by events outside the country.

Venezuela: Even though there is some news coverage, the conclusion is similar: In 2008, Venezuela’s economy was growing (albeit slower than before), its debt was shrinking and figure 4 exhibits no obvious links between movements of the spread

and either its economic performance or domestic news. Thus, also here, contagion seems to be the only sensible explanation of the depicted spread movements.

Uruguay: Here, the picture is somewhat less clear. Uruguay's debt was rising and its primary surpluses deteriorated as it headed into a brief recession at the beginning of 2009. Seemingly inconsistently with consumption smoothing, Uruguay's external debt was shrinking in this recession. The major spread movement occurred at a time where GDP was growing slowly, a primary surplus was due to realize and debt started to shrink. This suggests that, similar to El Salvador and Venezuela, the spread is very much driven by foreign events. However, at least one domestic event seems to be relevant: We see a brisk spread increase at the day before Uruguay's central bank president resigned, which was taken as a sign of political instability by contemporary observers.

For this crisis, Lizarazo's model at once fails and works perfectly well: On the one hand, we see that the major upward movement of the spread months before the loss for Ecuador's lenders materializes, viz. event 6 occurs. Additionally, lenders lost around \$2.3 bn in case of Ecuador, compared with losses of more than \$30 bn a decade earlier in Russia, according to calculations by Duggar and Cantor (2012). This means that, in contrast to the three aforementioned crisis, contagion is no plausible explanation for the synchronized upward movements of the spread.

Yet, the mechanics behind the spread movements in Lizarazo's model provides a suitable rationale for the spread movements: in the rich world, financial markets collapsed between the middle of September 2008 and late October 2008. This shrank lenders' wealth and (supposing Lizarazo's preferences) increased their risk aversion, which leads to the observed steady and comparatively slow increase in the spread in this period of time.

4.5 Individual crisis

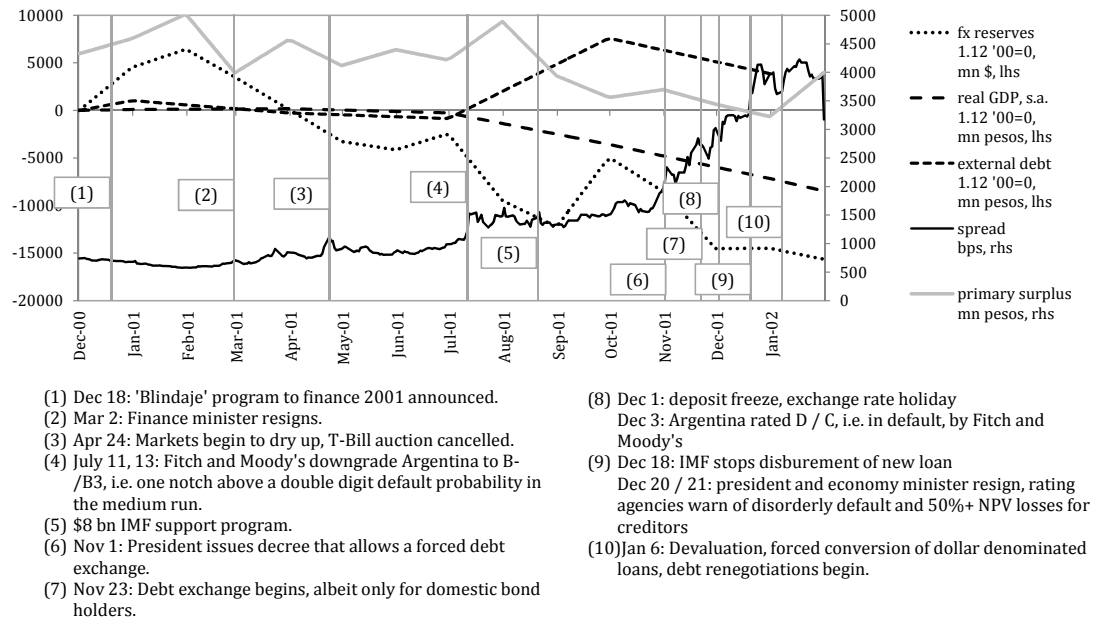
4.5.1 Argentina 2001 / 2002

The detected irregularity is part of Argentina's default in late 2001, of which figure 5 on page 30 presents a visual summary.

Even though Argentina halved its reserves in 6 months, its peg to the dollar was still in place when it defaulted. Thus, in contrast to Mexico in 1994, Argentina's crisis not mainly a currency crisis. We see that the spread increased stepwise over nearly half a year from moderately high to extreme levels. This slow increase is a clear indication that Argentina's default is inconsistent with the hypothesis of Cole and Kehoe (2000), that a default is triggered by a sudden spike in interest rates. We see also that debt has probably been too volatile to be consistent with Grossman and van Huyck (1988)'s approach of motivating debt issues with a productive use of debt. The long and difficult renegotiations after the default (cf Sturzenegger and

Zettelmeyer, 2007, pp.182) suggest that lenders did not view Argentina's default as an excusable accident.

Figure 5: Argentinas default



The figure also indicates that the implication of models like Cole and Kehoe (1995) – that a the precise timing of a default is random but happens in an environment of high interest rates – is also not consistent with the actual events: before the government forced local institutions into debt swap deals on November 6, the spread was mostly below 1000 bps. It increased dramatically on event 6, which was interpreted as strong indication that Argentina was heading into a default. During November, the Argentinean government was running out of options and chose to impose a de facto haircut¹¹ on agents under its authority – probably in the hope that it might gain enough fiscal leeway to meet IMF's targets. However, the leeway was not large enough, leading to a delay in the disbursement of IMF funds and therewith, an outright default a few weeks later.

This evolution of events is very much consistent with a baseline Eaton and Gersovitz type model, viz hypothesis 1. Argentina's external debt was just below 60% of GDP valued at the fixed exchange rate. Argentina's economy was already faltering for some time and headed into an outright recession in the second half of 2001. As we would expect from a consumption smoothing government, external debt increased. Because the economy was already close to the default region, the spread increased to levels above 1500 bps at that time. The continuation of Argentina's recession in Q4 2001 seemed to have pushed the economy in the default

¹¹Estimated to at least 25% by Sturzenegger and Zettelmeyer (2007, p.179).

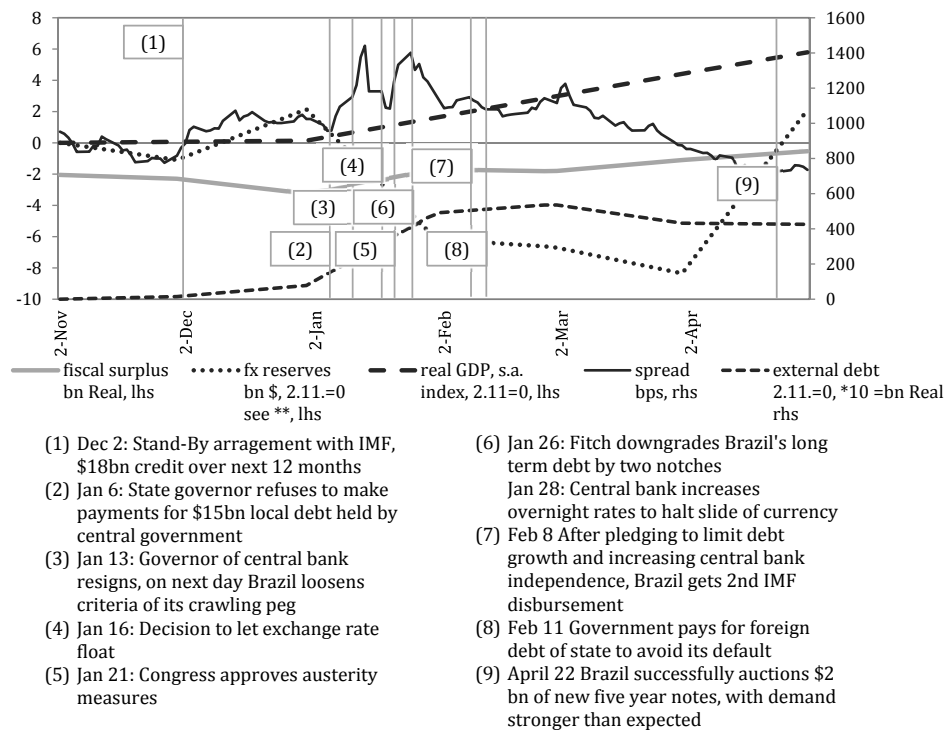
zone: markets dried up and the spread increased to sky high levels, Argentina declared an outright default shortly after.

Remarkably, Argentina ran a primary surplus during most of the time, which is a clear indication of pro cyclical government spending as implied by the baseline Eaton and Gersovitz type model: As Argentina headed into a recession, government revenue will surely have crumbled substantially. To maintain a primary surplus nonetheless requires to cut back government spending when revenue delines.

4.5.2 Brazil 1999

This irregularity occurred in a time of severe crisis, which is summarized in figure 6.

Figure 6: Brazil's crisis in the beginning of 1999



** Contemporary news has been filled with notes that Brazil has lost more than half of its currency reserves in a few months. Yet, most time series for currency reserves offered by Brazil's central bank do not exhibit this move. However, series 3544 (International reserves, Cash concept), which was discontinued in 2002, does. The displayed time series is therefore 3544. For later crisis, I extrapolated this series with series 2945, which exhibits the change in cash reserves defined slightly different but still mirrors all major movements in 3544.

At the beginning of the crisis, Brazil moved out of a recession and was in a crawling peg. By defending it in face of an increasing amount of foreign currency debt (Brazil held net sovereign savings of 5 bn Reais in April 1998, which turned to 80 bn Reais

net debt in January 1999) and a slowing down economy, Brazil shrank its foreign currency reserves from a peak of \$72 bn on April 1, 1998 to \$33 bn on January 1, 1999. This made Brazil's commitment to the peg increasingly incredible and triggered an abandonment of the peg (event 4).

From the close synchronization of exchange rate related events and spread movements we see that also this crisis is seemingly closely linked to the abandonment of a fixed exchange rate and the succeeding devaluation. Yet, there are noteworthy differences to Mexico's devaluation in 1994: We see a major upward movement just before Brazil loosened its peg. The most plausible interpretation of this is a leakage of informations to market participants, of which the then-governor of Brazil's central bank was indeed convicted later.¹² Interestingly, a minor rally of spreads started at the very day a Stand-By arrangement with the IMF was announced. This can be interpreted as a perverse effect of the IMF program: the announcement of the Stand-By arrangement (International Monetary Fund, 1998, p. 389) casted light on the dire state Brazil's state finances and may have brought market's attention on this issue, which might have been overlooked for some time otherwise. Last, we see that the spread decline is, in contrast to Mexico in 1995, accompanied with a decrease in external debt and an improvement of the fiscal surplus. This makes this period of time well consistent with an Eaton and Gersovitz type model.

Combined, these observations indicate that this crisis is a currency crisis, nonetheless the Eaton and Gersovitz model has some explanatory power: The devaluation can be read as a sudden increase of the external debt, which moved the economy closer to the default region. The government reacted by trimming its fiscal deficit and used resources lent by the IMF to cut its external debt. In combination with a quarter of positive GDP growth, this moved the economy away from the default region and induced a reduction of the spread.

4.5.3 Colombia 1999 – 2000

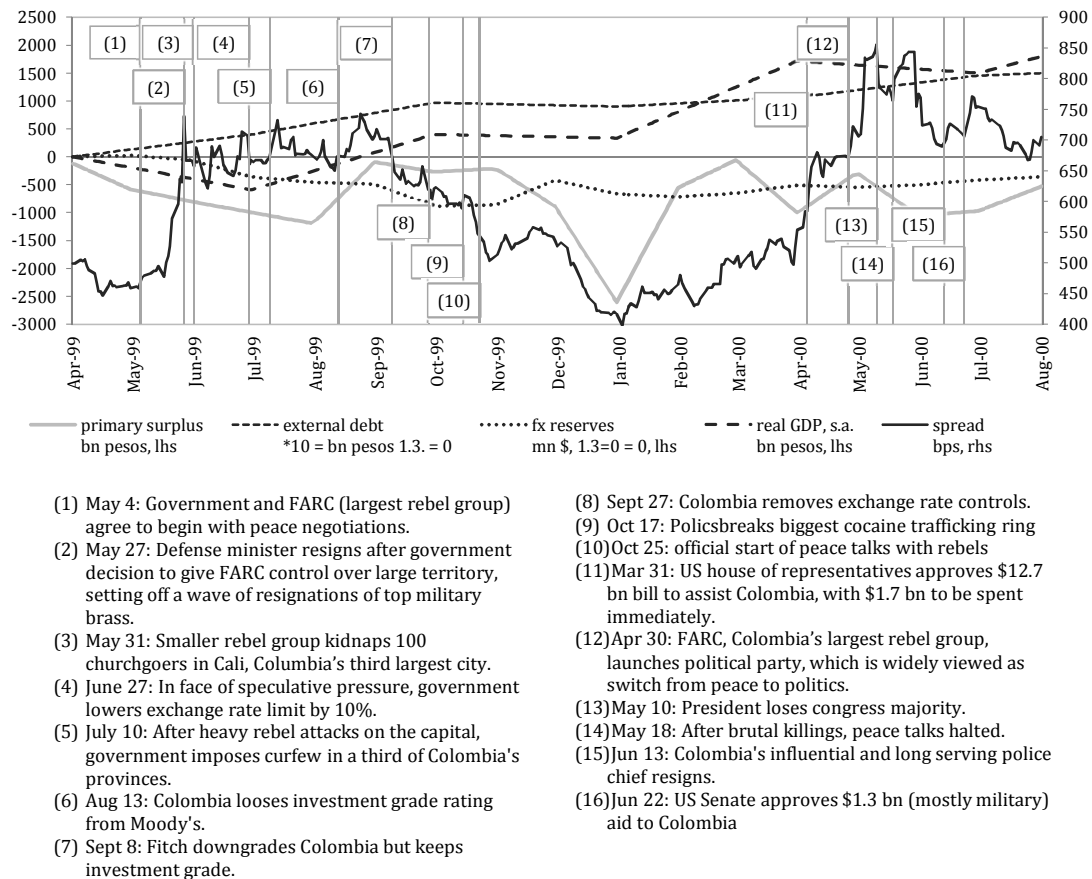
After decades on conflict, Colombia's president Andrés Pastrana began his presidency in 1998 with assiduous efforts to begin peace talks with Colombia's main rebel groups. In 1999, rubber was to hit the road: Pastrana began negotiations with FARC, the largest rebel group, and pledged to give the group control over a territory in Colombia. At the beginning of the investigated period, Colombia was a deep recession, with real GDP having shrunk by more than 7% in Q2 1999 relative to the same quarter in the previous year. Figure 7 on page 33 provides a visual summary.

So, in early 1999 Colombia was in a severe recession, its debt was rising and the government continually faced primary deficits. Yet, it appears to be unlikely that a reduced distance to the default region fueled the observed rapid spread increases.

¹²For details see *Just when it looked safe*. The Economist, May 1th – May 8th 1999.

This is because, such an approach seems inconsistent with the rather abrupt jump of the spread at the end of May 1999. Rather, one would expect such a movement to be gradual, in smaller steps within a few weeks, as happened in Argentina. The contemporaneous occurrence of event 2, i.e. tensions even within the government whether president Pastrana's generous concessions might prop up the rebels and thus further destabilize Colombia, seems to be a much more plausible explanation.

Figure 7: Irregularities in Colombia 1999 and 2000



While the increase of the spread in 1999 is thus likely to be linked to worries on Colombia's long and medium term stability as a country, the decrease in the fall of 1999 seems to be mostly driven by a recovery of Colombia's economy: in Q3 1999, Colombia's recession moderated and ended with Q1 2000. This is mirrored by stabilizing external debt but is not visible in the state finances, we see very large primary deficits in the winter 1999/2000.

Thus, the spread increase is not likely to be triggered to a substantial reduction of the distance to the default region and also the decrease appears to be only loosely consistent. The only model which can produce such "unfounded" spread moves is Cole and Kehoe (2000): if hypothesis 5 applies, the whole spread movement was

unfounded and the decrease thus only a return of markets to a rational evaluation of Colombia's situation.

Colombia grew throughout 2000, which makes the renewed increase in the spread one of the most peculiar movements in this paper: due to the growing economy, Colombia's state finances improved and debt grew mildly for the most part, yet the spread increased by 180 bps between March 29 and April 10 2000. If one is unwilling to see this as a renewed unfounded market panic, one finds a possible explanation by observing that on March 31, the US house of representatives approved a comprehensive bill to assist Colombia in its fight against drug production and trafficking (event 11). The absence of other events in this period of time suggests that financial markets might have seen this measure as a severe threat for Colombia, possibly because many market participants shared the widespread skepticism on benefits of the "war on drugs".¹³ This view is confirmed by event 16, where a senate approval on \$1.3 bn of military aid for Colombia is also followed by an increase in the spread.

Thus, in case of this irregularity, the only applicable hypothesis is 5: the observed irregularities were generated by unfounded market panics. Yet, the close synchronization of spread movements and news event, particularly for the second irregularity in 2000, suggests that these movements were not unfounded but rather due to concerns of Colombia's long term survival as a country, which is well beyond the scope of available models.

4.5.4 Ecuador 2000

The algorithm detects an irregularity at the end of August. Looking up the spread we find that on August 25, the spread jumped more than 800 bps to about 2200 bps, remained there and dropped again by more than 850 bps on August 31. The abruptness of these moves suggests that the origin is unrelated to changes in the default risk but rather due to changes in the composition of the index. Indeed, we find that Ecuador completed the bond exchange following its default in 1999 on August 23 (cf Sturzenegger and Zettelmeyer, 2007, p.164), the old bonds were thus probably removed from the index shortly after and generated this movement.

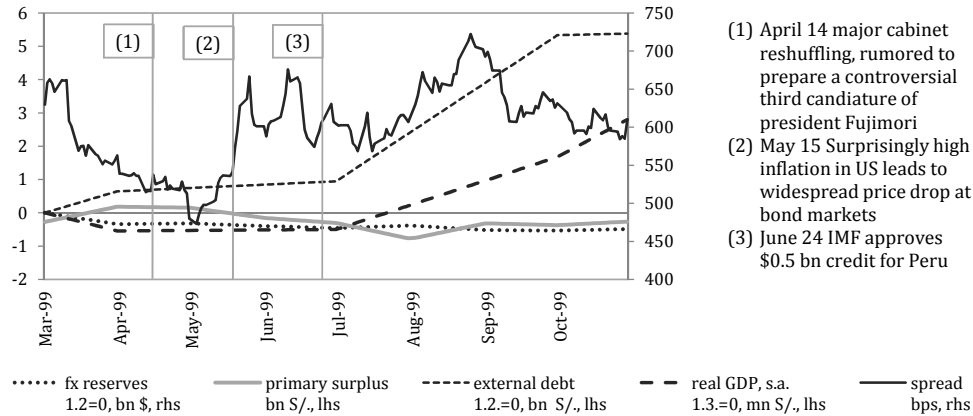
4.5.5 Peru

May 1999 As visible in figure 2, the spread for Peru decreased from a peak of around 1000 bps in 1998 back to levels of 700 bps and below. This decrease continued in the spring of 1999, to levels below 500 bps in early May 1999. The sudden

¹³For arguments in this favor see *Ending the war on drugs*. The Economist, January 2nd – January 9th 1999.

increase back to levels around 700 bps is detected as irregularity, figure 8 presents an overview.

Figure 8: Peru around the irregularity in May 1999



In the spring of 1999, Peru was moving out of a brief recession, which spanned from Q2 1998 to Q1 1999. Growing debt and a renewed drop in primary surplus in July 1999 indicate that the recovery was bumpy and indeed, GDP growth gained pace only in Q4 1999. Thus, the evolution of the time series is broadly consistent with an economy moving a bit away from the default region, just to move even closer (due to the increased debt) after a few weeks. However, the steepness of the spread increase in May would be only consistent with an implausibly brisk move towards the default region. It seems therefore likely that event 2, which generated a general upward move in global bond yields, is responsible for this move, not events in Peru.

June 2000 – June 2001 Even though the algorithm detected two separate crisis, both can be viewed as two phases in one of the most turbulent years in Peru's history. Figure 9 on page 36 presents a visual summary of the events.

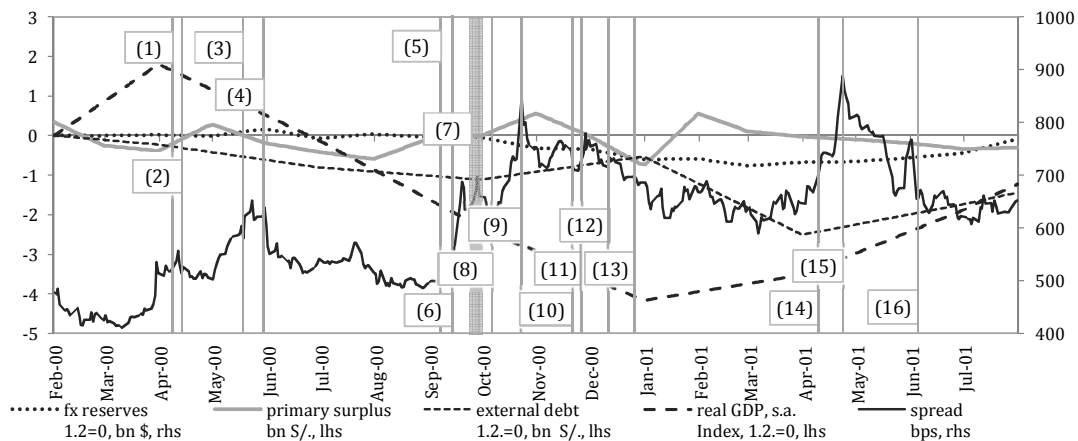
In the last quarter of 1999, Peru began to grow after nearly two years of weak economic performance. This is mirrored by a general decrease of external debt as well as primary surpluses at the beginning of the investigated period. In the second half on 2000, amidst a steady increase of political uncertainty due to president Fujimori's call for new elections and his later resignation, Peru entered a brief but steep recession, which reached its nadir in the first quarter of 2001. We observe that at this time, as we expect a consumption smoothing government to do, the primary surplus turned into a deficit and external debt increased. This seems to indicate a linkage of the spread movement in the fall of 2000 to Peru's economic performance. However, we also see a decrease in the spread between the middle of June and September 2000, at a time where the distance of the economy to the default region was already shrinking. Yet, calling in mind that Peru was in a political turmoil at

that time indicates that there is no reason why the default region could not have moved: Possible successors of Alberto Fujimori may have a smaller discount factor, decreasing the relative attractiveness of a default. However, at that time, there is no news on an emerging successor, which makes an explanation via hypothesis 3 not fully convincing. This leaves us with Peru's missed payment as explanation, on which Moody's press release offers a good summary:

Moody's said that the downgrade reflects missed interest payments on Peruvian Brady bonds, which were due on September 7th. The rating agency stated that the missed payments are a consequence of a legal dispute that limits the ability of the Peruvian government to comply with its Brady bond obligations. Moody's indicated that its decision does not reflect unwillingness to pay on the part of Peru. The Peruvian government has indicated its desire to honor its Brady obligations in full before the 30-day grace period, which expires on October 7, 2000.

And indeed, Peru made the payment within the grace period.

Figure 9: Peru's crisis in 2000/2001



- | | |
|---|---|
| <p>(1) Apr 8: General election, marred by fraud charges against incumbent Alberto Fujimori, who stands for a third term even though this is constitutionally dubious.</p> <p>(2) Apr 13: government announces that election result did not turn out a clear winner, announces run-off in early June.</p> <p>(3) May 18: Challenger Alejandro Toledo drops out due to expectations of fraud in run-off election.</p> <p>(4) May 29: Alberto Fujimori declared as winner of run-off.</p> <p>(5) Sept 7: Peru misses \$80 mn interest payment due to legal dispute.</p> <p>(6) Sept 16: Videotape leaks which shows chief of national intelligence service bribing opposition politician.</p> <p>Sept 17: Present Fujimori calls for new election just weeks after the beginning his new 5 year term.</p> <p>Sept 19: Moody's downgrades Peru due to missed payment.</p> <p>(7) Late Sept: Fujimori's authority crumbles, legislators leave his party, ending congress majority.</p> <p>(8) Oct 5: Moody's upgrades Peru's rating as legal dispute</p> | <p>(9) Oct 23: Ex chief of intelligence returns to Peru, igniting fears of a military coup.</p> <p>(10) Nov 21: Fujimori resigns.
Nov 22: Congress declares Fujimori "morally unfit" for office, making his resignation irrelevant, and chooses successor</p> <p>(11) Nov 26: New cabinet forces army chiefs (who were feared to prepare a military coup) to resign, decide date for special election on April 8 2001.</p> <p>(12) Dec 12: Moody's publishes negative outlook for Peru.</p> <p>(13) Dec 21: Caretaker government discovers huge mesh of intrigue and corruption left behind by Fujimori government.</p> <p>(14) Apr 9: In first round of elections, Alan García, the president preceding Fujimori who led the country into chaos, secures second place.</p> <p>(15) Apr 20: Alejandro Toledo, the contender from the last election, leads in polls
Apr 21: Peru's military mistakes US missionary plane for drug transport and shoots it down, ignites tensions between US and Peru</p> <p>(16) Jun 4: Toledo elected as president.</p> |
|---|---|

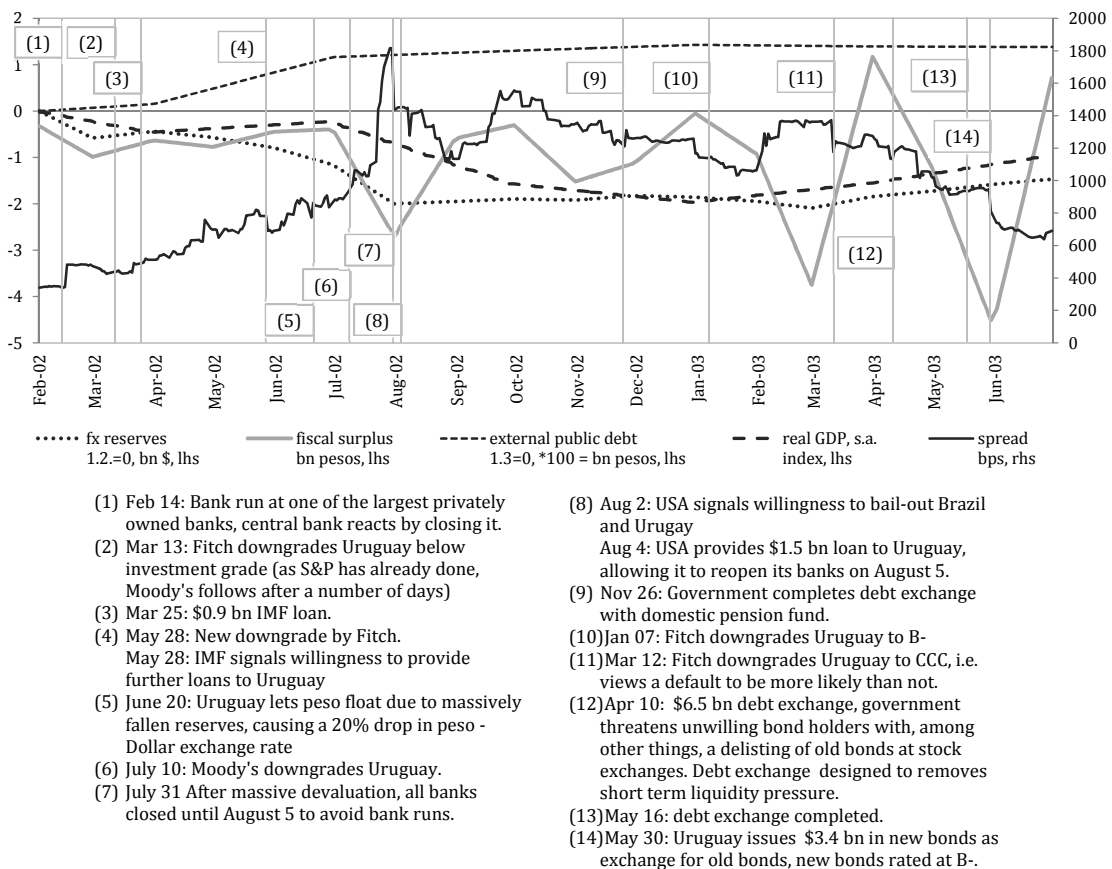
In case of the last sudden increase in the spread in late April 2001, an explanation via economic fundamentals seems impossible: the brief recession was moderating, external debt was shrinking and the government ran a series of primary surpluses. A more suitable explanation is the dire choice of possible presidents left after the first round of the election: A former president, Alan García, who left the country in chaos and faced legal charges at the time, and Alejandro Toledo, who has been viewed as political amateur and proved mistake-prone (cf Levitsky and Sanborn, 2001).

Summing up, Peru's evolution in 2000/2001 is way beyond the reach of either hypothesis 1 or 3. Short time spans are however consistent, which makes an application of hypothesis 5 also not particularly convincing.

4.5.6 Uruguay 2002 – 2003

The detected irregularities mark the two phases of market turmoil that preceded Uruguay's debt exchange in May 2003. Figure 10 presents a visual summary of the events.

Figure 10: Events around Uruguay's debt exchange



In Q1 2002, Uruguay entered its third year in recession. Its real GDP had shrunk

about 12% and external debt had been rising steadily in this period of time. To make things worse, the economy of neighboring Argentina collapsed, which further increased the pressure on Uruguay. Until event 5, Uruguay's government was also defending a crawling peg. The massive devaluation increased the difficulties of Uruguay's banks and forced to government to introduce a bank holiday (event 7, see de la Plaza and Sirtaine (2005) for details). Uruguay was able to reopen its banking sector, to avoid capital controls and to avoid a further economic collapse probably only due to the US loan (event 8). Even though these events are not fully in the scope of the available real models, the overall evolution of events until event 10 is quite consistent with a baseline Eaton and Gersovitz model: the economy was moving closer to the default region and the banking crisis triggered by the devaluation can be viewed as an additional income shock, which moved the economy even closer to the default region. Without the loan, Uruguay would have had to default shortly after. With these additional resources, Uruguay moved away from the default region, which is indicated by a temporary decrease of the spread in the late summer of 2002. From this point on, no model seems able to capture the events: Contemporary news on event 9 suggest that Uruguay's government tried everything it could to generate sufficient financial leeway to roll over a large international bond maturing in spring 2003. This was not successful, which forced Uruguay into a debt exchange.

5 Conclusion

Thus, we saw that available models have something to say about virtually every recent sovereign debt crisis in Latin America. Yet, in terms of single country crisis only Argentina in 2001/2002 and, with qualifications, Brazil in 2002 are fully consistent with available models. For all other crises, there are events or periods in time that are consistent with no available model. A major reason for this is that many crises are related to the abandonment of fixed exchange rates or currency crisis, which are by construction out of the scope of the available models. In terms of crises that occurred simultaneously in some / many countries, the only available model for contagion seems capable – albeit a quick decline of spreads even though lenders incurred a loss, which is observed sometimes, is beyond its scope.

These observations show that a major venue for future theoretical research in sovereign debt are nominal models. That nominal models have not been built yet even though excellent and very experienced economists like Satyajit Chatterjee, Timothy and Patrick Kehoe, Enrique Mendoza and others have been in this field suggests that this task is daunting. Nonetheless, the important role of exchange rate movements depicted in this study highlights that it has to be done.

For policy makers and policy advisers, this is bad news because it means that

we currently do not have models for sovereign defaults in emerging economies that can be confidently used for forecasts and simulations. For developed economies, the situation is even more dire. I have developed a possible structural model for the reduced form models commonly used in the literature. But this model, and probably any other neoclassical model of the government that can be fitted into an exogenous endowment with an AR(1) law of motion, implies pro cyclical government spending, which is quite common in developing economies (see Alesina et al., 2008) but not in developed economies. That is, our available models have nothing to say about the latter. Policy advisers that seek insight for these countries do thus not even have models with a patchy track record – they have none.

References

- Mark Aguiar and Gita Gopinath. Defaultable debt, interest rates and the current account. *Journal of International Economics*, 69(1):64–83, 2006.
- Alberto Alesina and Guido Tabellini. A Positive Theory of Fiscal Deficits and Government Debt. *The Review of Economic Studies*, 57(3):403–414, 1990.
- Alberto Alesina, Guido Tabellini, and Filipe R Campante. Why Is Fiscal Policy Often Procyclical? *Journal of the European Economic Association*, 6(5):1006–1036, September 2008.
- Cristina Arellano. Default risk and income fluctuations in emerging economies. *American Economic Review*, 98(3):690–712, 2008.
- Cristina Arellano and Ananth Ramanarayanan. Default and the Maturity Structure in Sovereign Bonds. *The Journal of Political Economy*, 120(2):187–232, 2012.
- D Benjamin and M Wright. Recovery before redemption: A theory of delays in sovereign debt renegotiations. *Manuscript, State University of New York*, 2009.
- Jeremy Bulow and Kenneth Rogoff. Sovereign Debt: Is to Forgive to Forget? *The American Economic Review*, 79(1):43–50, 1989a.
- Jeremy Bulow and Kenneth Rogoff. A Constant Recontracting Model of Sovereign Debt. *The Journal of Political Economy*, 97(1):155–178, 1989b.
- John Cavanagh and Richard Long. Introducing the J.P. Morgan Emerging Markets Bond Index Global (EMBI Global). Methodology brief, J.P. Morgan, New York, 1999.
- Satyajit Chatterjee and Burcu Eyigungor. Maturity, Indebtedness, and Default Risk. *The American Economic Review*, 102(6):2674–2699, 2012.

- Harold Cole and Patrick J Kehoe. The role of institutions in reputation models of sovereign debt. *Journal of Monetary Economics*, 35(1):45–64, 1995.
- Harold Cole and Patrick J Kehoe. Reviving reputation models of international debt. *Federal Reserve Bank of Minneapolis Quarterly Review*, 21:21–30, 1997.
- Harold Cole and Patrick J Kehoe. Models of Sovereign Debt: Partial Versus General Reputations. *International Economic Review*, 39(1):55–70, 1998.
- Harold Cole and Timothy Kehoe. Self-Fulfilling Debt Crises. *The Review of Economic Studies*, 67(1):91–116, 2000.
- Gabriel Cuadra and Horatio Sapriza. Sovereign default, interest rates and political uncertainty in emerging markets. *Journal of International Economics*, 76(1):78–88, 2008.
- Mario Damill, Roberto Frenkel, and Martín Rapetti. The Argentinean Debt: History, Default and Restructuring. *Economica*, 6(3):29–90, 2005.
- Luis de la Plaza and Sophie Sirtaine. *An Analysis of the 2002 Uruguayan Banking Crisis*. *World Bank Policy Research Working Paper*, 3780, December 2005.
- Pablo D’Erasmus. Government reputation and debt repayment in emerging economies. *Manuscript, University of Texas at Austin*, 2008.
- Elena Duggar and Richard Cantor. Investor Losses in Modern-Era Sovereign Bond Restructurings. Special comment, Moody’s Investors Service, September 2012.
- Jonathan Eaton. Sovereign Debt, Reputation and Credit Terms. *International Journal of Finance & Economics*, 1(1):25–35, 1996.
- Jonathan Eaton and Mark Gersovitz. Debt with potential repudiation: Theoretical and empirical analysis. *Review of Economic Studies*, 48(2):289–309, 1981.
- Barry Eichengreen, Ricardo Hausmann, and Ugo Panizza. Currency Mismatches, Debt Intolerance and Original Sin: Why They Are Not the Same and Why it Matters. *National Bureau of Economic Research Working Paper Series*, No. 10036, 2003.
- Robert Flood and Nancy Marion. Perspectives on the recent currency crisis literature. *International Journal of Finance & Economics*, 4(1):1–26, 1999.
- Roberto Frenkel and Martín Rapetti. A Concise History of Exchange Rate Regimes in Latin America. Centre for Economic and Policy Research, April 2010.

- Herschel Grossman and John van Huyck. Sovereign Debt as a Contingent Claim: Excusable Default, Repudiation, and Reputation. *American Economic Review*, 78(5):1088–1097, 1988.
- Juan Carlos Hatchondo, Leonardo Martinez, and Horatio Sapriza. Heterogeneous Borrowers in Quantitative Models of Sovereign Default. *International Economic Review*, 50(4):1129–1151, 2009.
- Juan Carlos Hatchondo, Leonardo Martinez, and Horacio Sapriza. Quantitative properties of sovereign default models: Solution methods matter. *Review of Economic Dynamics*, 13(4):919 – 933, 2010.
- International Monetary Fund. IMF Approves Stand-By Credit for Brazil. *IMF Survey*, 27(23):385 – 389, December 1998.
- Kenneth Kletzer and Brian Wright. Sovereign Debt As Intertemporal Barter. *The American Economic Review*, 90(3):621–639, 2000.
- F Larraín and Andres Velasco. Can swaps solve the debt crisis?: lessons from the Chilean experience. *Princeton studies in International finance*, 1990.
- Steven Levitsky and Cynthia Sanborn. Opinion: A Hard Choice in Peru. *The New York Times*, May 9 2001.
- Sandra Lizarazo. Contagion of financial crises in sovereign debt markets. *MPRA Working Paper*, 40623, 2009.
- Sandra Valentina Lizarazo. Default risk and risk averse international investors. *Journal of International Economics*, 89(2), 2012.
- Maximilian Ludwig. Sovereign Borrowing for Dubious Reforms. *CIGE Working Paper*, n. 29, 2013a.
- Maximilian Ludwig. Government debt and default in a minimal state. *CIGE Working Paper*, n. 30, 2013b.
- Enrique G Mendoza and Vivian Z Yue. A General Equilibrium Model of Sovereign Default and Business Cycles. *The Quarterly Journal of Economics*, 127(2):889–946, 2012.
- Charlotte L Needham, Paul Rawkins, David Riley, and Mariarosa Verde. Fitch Ratings Sovereign 2012 Transition and Default Study. Special report, Fitch Ratings, March 2013.
- P A Neumeyer and F Perri. Business cycles in emerging economies: the role of interest rates. *Journal of Monetary Economics*, 2005.

- Reuters. Puerto Rico policymakers report key budget deal. reuters.com, June 2013.
URL <http://www.reuters.com/assets/print?aid=USL2N0E01G620130612>.
- Alan Schankel. Puerto Rico’s debt overload. Janney Fixed Income Strategy, Janney Montgomery Scott LLC, July 2012.
- Alan Schankel. Puerto Rico on the high yield precipice. Janney Fixed Income Strategy, Janney Montgomery Scott LLC, April 2013.
- Garry J Schinasi, Charles F Kramer, and R Todd Smith. Financial Implications of the Shrinking Supply of U.S. Treasury Securities. International Monetary Fund, March 2001.
- Federico Sturzenegger and Jeromin Zettelmeyer. *Debt Defaults and Lessons from a Decade of Crises*. The MIT Press, Cambridge, Massachusetts, 2007.
- Merxe Tudela, Elena Duggar, Albert Metz, and Bart Oosterveld. Sovereign Default and Recovery Rates, 1983-2010. Special comment, Moody’s Investors Service, May 2011.
- Martín Uribe. A fiscal theory of sovereign risk. *Journal of Monetary Economics*, 53(8):1857 – 1875, 2006.
- Kathy Yuan. The Liquidity Service of Benchmark Securities. *Journal of the European Economic Association*, 3(5):1156–1180, January 2005.
- Vivian Yue. Sovereign default and debt renegotiation. *Journal of International Economics*, 80(2):176–187, 2010.

A Appendix

A.1 The economic setup in Cole and Kehoe (2000)

Cole and Kehoe assume that households’ preferences are

$$\hat{U}_0 = \sum_{t=0}^{\infty} \beta^t \mathbb{E}_0 \left[(c_t + v(g_t)) \right]$$

where c_t is consumption, g_t is government spending, β is the subjective discount factor and $v(\cdot)$ is a strictly concave and monotonously increasing function. Hats will signal that this variable differs from its counterpart in section 2.3. The government finances its spending with a constant proportional tax of rate $\hat{\tau}$ and can issue

discount bonds that will be bought by international lenders. Endowment is produced by the households using capital, but the depreciation is 100%. Household's budget constraint is

$$c_t + \hat{k}_t = (1 - \hat{\tau})\hat{\kappa}_t f(\hat{k}_{t-1}) \quad (5)$$

$\hat{\kappa}_t$ takes the value 1 if the government has never defaulted and $\kappa < 1$ if the government defaulted at least once in the past. Thus, in contrast to κ_t in the exposition above, the value of $\hat{\kappa}_t$ can change only once. $f(\cdot)$ is a strictly concave and monotonously increasing function that satisfies the Inada conditions. Indices signal the time when the value of a variable was determined, thus Cole and Kehoe assume that households decide today how much capital they shall use to produce endowment in the next period.

Government's budget constraint is

$$g_t + z_t B_{t-1} + (1 - z_t)\delta B_{t-1} = z_t q_t B_t + \hat{\tau}\hat{\kappa}_t f(\hat{k}_{t-1}) \quad (6)$$

where q_t and B_t are defined similar to section 2.3.

Households can only maximize private consumption. Without loss of generality, assume that $f(\hat{k}_{t-1})$ has the functional form \hat{k}_{t-1}^ϕ , households will then set \hat{k}_t according to:

$$\hat{k}_t = \left(\mathbb{E}_t[\phi\beta\kappa_{t+1}] \right)^{\frac{1}{1-\phi}}$$

This allows to state government's objective function as

$$\begin{aligned} \hat{U}_0 = & \sum_{t=0}^{\infty} \beta^t \mathbb{E}_0 \left[(1 - \hat{\tau})\hat{\kappa}_t (\phi\beta\mathbb{E}_{t-1}[\hat{\kappa}_t])^{\frac{\phi}{1-\phi}} - (\phi\beta\mathbb{E}_t[\kappa_{t+1}])^{\frac{1}{1-\phi}} \dots \right. \\ & \left. \dots + v \left(z_t q_t B_t - z_t B_{t-1} - (1 - z_t)\delta B_{t-1} + \hat{\tau}\hat{\kappa}_t (\phi\beta\mathbb{E}_t[\kappa_{t+1}])^{\frac{\phi}{1-\phi}} \right) \right] \end{aligned}$$