Chapter 1

Introduction

There is a clear consensus both in the academic literature and in the policy

debate that sound management of fiscal risks is essential for both fiscal sus-

tainability and macroeconomic stability of sovereign countries (Brixi & Schick

2002, George Kopits 2014, IMF 2016). One of the classes of fiscal risks that

were particularly neglected in the usual fiscal sustainability analysis is that

related to contingent liabilities, that is, liabilities whose occurrences depends

on the outcome of an uncertain event (Brixi & Schick 2002). A second impor-

tant development in recent years is that with the increased decentralization

in the provision of public services, the contingent liabilities, both explicit

and implicit, arising from subnational governments (SNGs) are increasingly

relevant for fiscal sustainability analysis. This relevance is higher the more

spending and taxation powers are given to the subnational entities in the

fiscal framework currently in place in a given country.

Although the above characterization could be employed to describe the

recent economic history of several countries, Brazil might as well be the

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canonical example. A federation with one Federal District, 26 states, and

5,570 municipalities, Brazil experienced in the 80s and 90s repeated fiscal

crisis of subnational entities with three rounds of debt restructurings. These

episodes severely threatened the success of several macroeconomic stabiliza-

tion programs that hoped to control the three-to-four-digit annual inflation

rates that wreak havoc the Brazilian economy from 1980 through 1994. It

was only with the success of the Real Plan in fighting the hyperinflation,

and with a more comprehensive debt restructuring that aimed to correct the

underlying SNG fiscal problems, that the political and economic conditions

enabled for a complete reformulation of the fiscal institutions in place, cul-

minating with the publication of a Fiscal Responsibility Law (FRL) in 2000

(Manoel et al. 2013, p. 34-35).

The FRL was a comprehensive law that promoted several changes in the

institutions related to the Brazilian budgetary process. However, for the

purposes of this study, the focus will be on the controls that were put forth

for SGNs borrowings. Following the typology of borrowing controls used by

Ahmad et al. (2005) and first proposed by Ter-Minassian & Craig (1997),

Brazil has adopted both a rules-based control and an administrative control

for SNG borrowing. In a rules-based control, a fiscal rule is imposed that

directly constrains the SNG ability to borrow. In Brazil, the FRL adopted

both a golden rule and a debt ceiling rule. In an administrative control, the

central government has some form of direct control over the SGN borrowing.

In Brazil, if the central government must offer a guarantee for an individual

borrowing operation, then the Finance Ministry, through the National Trea-

sury Secretariat (NTS), must assess that entity “payment capacity” before

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the operation is authorized. The current methodology employed by NTS

was enacted in 2012 and makes use of several fiscal indicators to classify the

SGNs entities in different credit classifications, similar in spirit to the process

adopted by rating agencies in giving credit ratings. However, this method-

ology is currently being revised 1 , as the NTS is looking for an alternative

suite of fiscal indicators that are more transparent and more easily calculated.

In this context, the assessement of the statistical and practical significance

of both the current and the newly set of fiscal indicators used by the Na-

tional Treasury Secretariat to assess the fiscal sustainability of subnational

governments in Brazil is both necessary and timely.

The strand of literature on Early Warning Systems (EWS) for economic

crisis are particularly relevant for this endeavour. Following the seminal work

by Kaminsky et al. (1998) and Berg & Pattillo (1999) on currency crisis, it

was not long until fiscal crisis were also tackled (Manasse et al. 2003, Fuertes

& Kalotychou 2007, Baldacci et al. 2011, Berti et al. 2012, Dawood et al.

2017). In this study, the focus will be on what is usually called the paramet-

ric approach, that makes use of limited dependent variables models, such as

probit and logit. There are three main contributions. First, as usually true

in most countries, disaggregate fiscal data on regional governments tends to

have a much lower quality and standardization then those available for central

governments2 . This study aims to compile, consolidate and make available

1

The NTS published the new set fiscal indicators and opened the methodology

for a public revision process in the period of 10/05/2017 to 30/06/2017. The ma-

terial related to this revision is available at http://www.tesouro.fazenda.gov.br/

sistemagarantiauniao

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Although there are several initiatives in place in Brazil to modernize the information

available for SNGs, in the fiscal transparency evaluation conducted by the IMF in Brazil

completed in June 2016 and published in May 2017 it is noted that “Weaknesses in fiscal

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on machine readable format regional discriminated data on the fiscal vari-

ables that are needed to compute the fiscal indicators used by the NTS for

payment capacity evaluation. To the best of the author’s knowledge, this

database is inexistent today. The second contribution is the expansion of

the Early Warning System literature for dealing with subnational govern-

ments. Most of the studies focus on sovereign governments, but, as noted

by Ianchovichina et al. (2007), SGNs are sufficiently different from sovereign

governments and demand separate analysis. The third and final contribution

is that by recognizing a fiscal crisis as a rare event as suggested by King &

Zeng (2001), that is, a binary dependent variable with dozens to thousands

of times fewer ones than zeros, we make use of the bias-reduction method

first proposed by Firth (1993) and implemented by Kosmidis (2017) in the

R-package brglm.

The remainder of this study is organized as follows. Section 2 presents a

brief literature review on the main characteristics of early warning systems for

economic crisis and also give a general overview of the institutional context

under which the National Treasury Secretariat conducts its payment capacity

evaluations. Section 3 presents a descriptive analysis of the data and also

outline the econometric model used. Section 4 presents the empirical results

and section 5 summarizes our conclusions.

reporting also undermine the ability to assess the fiscal position and risks. Not all states

and municipalities comply with their reporting obligations, and information on subna-

tional finances is generally less timely and comprehensive than information on the central

governments. (IMF 2017, p. 62)”

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Chapter 2

Literature Review

As noted by Baldacci et al. (2011), the literature that aims to build mod-

els that can provide early warning signals of fiscal sustainability problems

tend to differ with respect to three major characteristics: the definition of

the crisis event; the statistical methodology employed; and the set of ex-

planatory variables used. Broadly following this differences, in section 2.1

we review theoretical definitions of fiscal sustainability in order to propose a

definition of fiscal distress1 event that will be used in this study. In section

2.2 we present a general formulation of the early warning system problem

and the methodological approach pursued in this study. Regarding the set

of explanatory variables, since the main objective of this study is to assess

the significance of the fiscal indicators used by the National Treasury Sec-

retariat in their mandate to evaluate the payment capacity of subnational

governments, the explanatory variables are already defined. Therefore we

let the presentation of the fiscal indicators for section 3.1 coupled with the

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For the purposes of this study, fiscal distress, fiscal stress, fiscal crisis, and debt crisis

will be used as synonymous

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exploratory analysis of the data.

2.1 Fiscal Distress

The focus of this study will be on the empirical analysis of the main determi-

nants of fiscal distress episodes in subnational governments in Brazil in the

2008-2016 period. Nevertheless, it is important a brief theoretical review of

the most used concepts of fiscal sustainability so that an appropriate char-

acterization of what fiscal distress event entails, or, and perhaps even more

importantly, what it do not entail.

There are a few distinct ways in which fiscal sustainability is defined in

the economic literature. Although they all in some way or another alludes to

the more general concept of sustainability, understood here as a process that

“meets the needs of the present without compromising the ability of future

generations to meet their own needs” (Brundtland 1987), the differences

are important for the interpretation of the empirical results and should be

emphasized at the outset.

A more narrow definition of fiscal sustainability equates it to solvency,

that is, the ability of an entity, in the case of this study a subnational gov-

ernment, to make payments in order to service its debt obligations on the

due date. Although certainly useful for corporations, this definition is far

too stringent when applied to governments. The reasoning is not as much

because governments do not actually default on its debt, but, as pointed out

by Burnside (2005), when it is clear that a policy mix is unsustainable, gov-

ernments tend to take remedial actions in order to avoid an outright default.

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A more useful definition of fiscal sustainability takes this into account and

can be equated “to a governments ability to indefinitely maintain the same

set of policies while remaining solvent” (Burnside 2005, pg.11). Therefore it

makes sense to speak of an unsustainable policy mix even though a default

on the debt never actually took place. For the purposes of this study, both

an explicit default on the debt and an unsustainable policy mix should be

considered an indicator of a fiscal distress event.

It is worth pointing out that in the definitions given so far, no distinction

was made between solvency and liquidity problems. A country may believe

itself to be solvent, but it still faces problems in meeting its obligations

because of cash flows problems. The reason we don’t pursue this distinction is

less based on the fact that there are no theoretical differences between the two

concepts, but because the empirical consequences of both difficulties are likely

to be observationally equivalent (Chuhan 2005, pg.89). Both solvency and

liquidity are related to an entity ability to pay. However, especially because

of the absence of clearly defined rules for bankruptcy in the public sector,

the government willingness to pay also becomes important, in a tradition

that goes back at least to Eaton & Gersovitz (1981). Again, however, for the

purposes of this study, both are fiscal crisis episodes stemming from ability

or willingness to pay are likely to be observationally equivalent.

One of the uses of fiscal sustainability that will not be used in this study

is related to the costs, in terms of economic efficiency or growth, related

to a given combination of fiscal and monetary policy. Although this use is

suggested by Burnside (2005), we shall make no claim in this study related

to it.

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After looking at the theoretical definitions of fiscal sustainability, its worth

to take a closer look into how previous literature on EWS defined the debt

crisis episodes for sovereign governments. Manasse et al. (2003) defines a

country to be in a debt crisis if either the government fails to meet principal

or interest payment on external obligation on the due date as classified by

Standard & Poor’s or if it receives a nonconcessional IMF loan in excess of

100 percent of its quota. Fuertes & Kalotychou (2007) considers a country to

be in default in a given year if the arrears increase over a threshold percentage

of external debt and a rescheduling agreement is reached in which the amount

of debt rescheduled exceeds the decrease in the arrears stock. Baldacci et al.

(2011) uses a more general definition and considers a fiscal crisis not only

the episodes of debt default or restructuring and recourse to exceptional

financing, but also an implicit default crystallized in high inflation rates and

a deterioration in market access measured by high bond yields pressures

(where high is those that yield spreads that are more than two standard

deviations away from the mean).

Although the empirical literature is of limited applicability in giving op-

erational guidance in defining fiscal crisis episodes for this study because of

differences in sovereign and subnational governments, it is possible to see

that the theoretical elements discussed of solvency and liquidity are present.

2.2 Early Warning Systems

Before we delve into the different methodological approaches used in the

literature in early warning systems, we need a general framework to capture

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the purpose of an EWS model. Following Fuertes & Kalotychou (2007), we

denote by dit the dummy variable that equals 1 if the state i had a crisis

event in period t and 0 otherwise. Since the objective is to signal crisis in

advance, the dependent variable yit of interest is forward-looking in nature,

and it takes the value of one if a crisis happens during an h time horizon,

that is

However, it is important to remark that the information set2 for predicting

yit is that available at time t − 1. To fix ideas, let the explanatory variable

be the primary balance as a ratio of GDP and let t = 2016. A prediction

ŷit = 1 from an EWS with horizon h = 1 implies that using the primary

balance as a ratio to GDP from 2015 backwards, the model is signalling a

potential crisis in 2016 for state i. Similarly, if h = 2, the model is signalling

a potential crisis in 2016 or 2017. Note that again only the primary balance

as a ratio to GDP from 2015 backward is used to make this prediction.

In a more general notation, if we let x denote the explanatory vari-

ables included in the model, and the past of x for state i as Xi,t−1 =

{xi,t−1 , xi,t−2 , . . . }, the prediction problem of an EWS with a given horizon

h is given by

In practice using the whole past Xi,t−1 of the explanatory variables is not

possible, and we will follow other studies using only the last period variables,

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The information set, usually denoted by Ωt consists of the set of all potential explana-

tory variables that could be included in a regression model.

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that is, xi,t−1 . This is not problematic as long as there are stock variables

that can capture the effects of flows from previous periods.

For estimating the function f in (2.2), there are two major approaches

in the literature on early warning systems. The “indicators” or “signaling”

approach and the multivariate regression analysis approach (Baldacci et al.

2011, pg. 5). The first approach belongs to the class of non-parametric

methods. Their essential characteristic is that they do not assume a spe-

cific functional form for f , and simply try to estimate a smooth relationship

between the explanatory and dependent variables. The second approach be-

longs to the class of parametric methods. In this case, a specific functional

form for f is assumed, and, with this knowledge at hand, the relevant param-

eters are estimated3 . In this study, we will take the latter approach. More

specifically, we will make use of a limited dependent variable model know as

logit regression4 .

As noted by Baldacci et al. (2011), the main reason for using the multivari-

ate approach in this study is the easily available null hypothesis significance

tests that can be conducted to assess the statistical significance of both in-

dividual variables and collection of variables. This allows for a clean way to

attain one of the objectives of this study, that is, to compare and contrast the

current and the newly set of fiscal indicators used by the National Treasury

Secretariat to assess the payment capacity of SGNs in Brazil.

3

James et al. (2013) is a nice introduction and overview of statistical learning tech-

niques, both parametric and non-parametric. Hastie et al. (2009) is a more advanced and

complete treatment.

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The specific characteristics of the model employed are discussed in section 3.2

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Chapter 3

Methods

3.1 Data

The majority of the explanatory variables used in this study are derived

from the fiscal reports made available by the National Treasury Secretariat

(NTS), who is responsible for collecting primary fiscal data from subnational

governments in Brazil. The consolidated dataset is available at https://

github.com/fjuniorr/junior2017. The focus of this section is to present

an exploratory and descriptive analysis of the fiscal indicators that are used

(or whose use is proposed in the new methodology) by the NTS in its payment

capacity evaluation.

The final dataset used in this study consists of fiscal indicators compiled

for the 26 states and the federal district from 2008 through 2016, totaling

n = 243 observations. Since the explanatory variables will be lagged 1 year,

the sample size is reduced from 2009-2016, totaling n = 216 for estimation

purposes.

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For the purposes of this study, the publication of a decree of financial

calamity1 will be the event that characterizes a fiscal crisis in a given state-

year. The reasoning is that, consistent with the discussion made in section

2.1, the decree of public calamity, although legally questionable2 , clearly

signals that the policy mix has become unsustainable, and, even if there are

still doubts about the states ability to pay in terms of solvency and liquidity,

definitely they don’t have the willingness to pay. Therefore the dummy

default dit will take the value of one in 2016 for the states of Rio de Janeiro

(RJ), Rio Grande do Sul (RS), and Minas Gerais (MG). Following previous

studies, we will use the time-horizon of one year h = 1, meaning that the

forward-looking independent variable yit will be equal to dit .

Table 3.1 presents descriptive statistics for the explanatory variables that

will be used in this study. With respect to the fiscal indicators of the current

methodology, four variables are especially different in the non-calamity/calamity

dichotomy. These variables show that the states that did not declared finan-

cial calamity have lower debt (Gross debt / Net current revenue - 0.86 ± 0.56

vs 2.19 ± 0.13), a less expensive payroll cost (Compensation of employees /

Net current revenue - 0.54 ± 0.09 vs 0.74 ± 0.04), more savings (Current fiscal

balance / Current revenue - 0.23 ± 0.17 vs 0.00 ± 0.12) and more investments

(Gross investment in nonfinancial assets / Total expenditure - 0.09 ± 0.04 vs

0.03 ± 0.01) than those states that did declare financial calamity. The ratio

Primary balance / Debt Service also shows that the calamity states were

1

http://economia.estadao.com.br/noticias/geral,

veja-por-que-os-estados-decretam-calamidade-financeira,10000096967

2

http://g1.globo.com/bom-dia-brasil/noticia/2016/12/

calamidade-financeira-de-estados-nao-e-reconhecida-pelo-governo.html

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running on average a primary deficit (−0.66 ± 1.00), although with too much

variability overall to characterize the differences between the two groups.

The same holds true for the ratio Social contributions / Social benefits that

shows that the states that declared calamity on average have a larger social

security deficit, although with large variability overall.

In regard to the fiscal indicators proposed by the new methodology, the

non-calamity/calamity difference is startling. Besides the already identified

higher debt and lower savings of calamity states, they have very large liquidity

problems compared to the non-calamity states (Current liabilities / Cash

and cash equivalents - 0.47 ± 0.36 vs 2.57 ± 0.70). Although with the data

available it is not possible to distinguish how big is the arrears stock, this

proxy indicates that the number is likely to be very large for calamity states.

One particular feature of the data that is not possible to gauge from table

3.1 is for how long the states that declared financial calamity in 2016 had

worse fiscal indicators than the other states. Figure 3.1 shows this evolution

for the fiscal indicators of the new methodology. The major trend is that

in the whole 2008-2016 the two groups of states were different, but, the

states that declared financial calamity in 2016 had a major fiscal deterioration

in 2015 and 2016. The evolution of Current liabilities / Cash and cash

equivalents is particularly marked, going from an average of 0.98 in 2014, to

1.88 in 2015 and ballooning to 2.57 in 2016.

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3.2 Econometric Model

In this section we mostly follow the expositions and results from Greene

(2011), Heij et al. (2004) and Davidson & MacKinnon (2004) adapted to the

notation used in this study.

To assess the relative importance of these several potential explanatory

variables, we need to use multiple regression analysis. The main model in

this study will be a logit model, which is a special case of a binary response

model. The binary response model can be derived from an underlying latent

variable model. The latent variable model is

This is the so-called index function, x0i,t−1 β is the systematic term and it

is an idiosyncratic error term. In our case, the latent variable yit∗ can be inter-

preted as either a propensity to default or as a measure of creditworthiness.

We don’t observe yit∗ , only yit according to

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Assuming that it has a standard logistic distribution we have that

The density (pmf) for each observation is given by

Therefore the log-likelihood `(β) for a random sample of size n = N · T

is given by

Maximization of 3.4 with respect to β gives the maximum likelihood

estimates.

Perfect Classifier

A common problem in applied work with binary dependent variables occurs

whenever there is a linear combination of the explanatory variables that can

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perfect classify every observation. That is

This phenomenon is called complete separation, and it produces infinite

parameter estimates in the usual numerical optimization algorithms that at-

tempt to make the value of 3.4 as close to zero as possible. Davidson &

MacKinnon (2004) gives three main reasons for the occurrence of this phe-

nomenon in practice. The sample size is very small, the model fits extremely

well, or the dataset is characterized by a much larger proportion of 1s or 0s.

It is likely the case that this study fulfills all three criteria, and therefore

a different estimation procedure is warranted. We make use of a maximum

penalized likelihood estimation first suggested by Firth (1993) and imple-

mented by Kosmidis (2017) in the R-package brglm. The advantage of this

procedure is that the even in cases of complete or quasi-complete separation

the estimates and their standard errors are always finite (Kosmidis 2017).

Inference and Goodness of fit

Inference on the logit model can be conducted in the usual fashion. The

significance of individual explanatory variables can be tested by the usual

t-test and the significance of joint variables can be tested by the likelihood

ratio test (Heij et al. 2004, p. 453). The former is based on the loss of log-

likelihood that results from the imposition of g independent restrictions on

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the parameters of a given model. The test statistic can be computed as

where l(θ̂u ) is the log-likelihood of the unrestricted model and l(θ̂r ) the

log-likelihood of the restricted model (the one with the restrictions applied).

The null hypothesis H0 : θ̂r is rejected in favor of the alternative H1 : θ̂u if

the test statistic is sufficiently large.

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Chapter 4

Results

Before presenting the econometric results, a word of caution is in order. It is

important to keep in mind that all the results rest on the definition of fiscal

distress event, which, in this study, produced only 3 crisis episodes across the

sample of 243 observations. As discussed in section 3.2, this raises issues of

bias in the estimates and problems related to complete and quasi-complete

separation. Although we are making use of a bias reduction method proposed

by Firth (1993) and implemented by Kosmidis (2017), by no means this puts

a definitive end to concerns related to the robustness of the results.

The general objective of this study is to test the statistical significance

of the fiscal indicators used the by the National Treasury Secretariat (NTS)

in payment capacity evaluations. However, because the NTS is currently

revising the methodology employed in those evaluations, two similar but still

different strategies could profitably be pursued in order to assess this set of

fiscal indicators. The first would began by considering all fiscal ratios ever

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defined by the NTS1 and from that set try to exclude variables that are

not significant. Following Kennedy (2008), this would be a “testing down”

specification approach. The second strategy would begun by taking into

consideration only the fiscal indicators that the NTS is proposing to become

the new standard, and from this set test if they could frutifully be augmented

by other fiscal ratios. Again, in the sense suggested by Kennedy (2008), this

would be a “testing up” specification strategy.

In this study, we followed both approaches. More specifically, in the “test-

ing down” approach, we began with a model that includes all explanatory

variables. From this full model, we considered two reduced nested mod-

els that were formed based on the fiscal indicators present in each payment

capacity methodology. This allows us to test for the joint significance of

several explanatory variables and directly compare the significance of each

methodology. In the “testing up” approach, the base model uses as explana-

tory variables only the 3 fiscal ratios proposed in the new payment capacity

evaluation. We then run individual regressions against each of the fiscal vari-

ables set forth in the Finance Minister Decree n 306, 10/09/2012. Finally,

all significant variables of the second stage are then added one by one to the

base model, and we conduct tests for the significance and look for changes

in sign and/or significance of the base variables. This strategy allows us to

better grasp if the proposed set of fiscal indicators of the new methodology

could usefully be expanded with previously used ratios while minimizing the

number of tests conducted. We don’t “test down” the full model because it

1

That is to say the fiscal indicators defined in the Finance Minister Decree n 306,

10/09/2012 and those in the newly proposed methodology available at http://www.

tesouro.fazenda.gov.br/sistemagarantiauniao

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is not clear what criteria should be used to exclude a given variable at each

stage without either going through all combinations or making more or less

arbitrary choices.

Two last remarks are in order before we delve into the results. First, the

ratio Gross Debt / Net current revenue is included in both methodologies but

obviously will be included only once in the full model. Similarly, the calcula-

tion rule of the ratio Current fiscal balance / Current revenue was changed in

the new methodology to Current expenses / Current revenue. However, since

they convey the same information, in order to avoid multicollinearity issues,

only the ratio Current expenses / Current revenue from the newly proposed

methodology will be used for estimation purposes. Second, we follow the sug-

gestion given in Gelman (2008) and scale all fiscal indicators with a division

by two standard deviations, that is, zi,t−1 = xi,t−1 − mean(x)/2 · sd(x). The

interpretation of the regression coefficients is equal to the mean ±1 standard

deviation, the same comparison of possible untransformed binary predictors.

To say it differently, the coefficients can now be interpretable as changes from

low to high values of the explanatory variable of interest.

Testing down

Table 4.1 presents the regression estimates for the three first models of in-

terest. Model 1 is the full model and includes all fiscal indicators used by

the NTS, be in the current or the new methodology. We also estimate two

nested models that correspond to particular restrictions applied to the full

model. Model 2 corresponds to a restricted model in which all variables of

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the current methodology are set to zero. Model 3 on the other hand, corre-

sponds to the restricted model in which all variables of the new methodology

are set to zero. Although, in this case, only the ratio Current liabilities /

Cash and cash equivalents is set to zero.

It is worth reminding the reader that, contrary to linear models, the

coefficients in non-linear models can’t be interpreted as marginal effects,

although we can interpret both the sign and the relative magnitude of the

relative magnitude of the coefficients.

In model 1, both Current liabilities / Cash and cash equivalents and

Gross investment in nonfinancial assets / Total expenditure were significant

at a 5% level. However, the sign in the latter was somewhat surprising. We

would expect that states that were on the verge of a crisis would reduce

their investment rate because of the discretionary nature of this type of

expenditure. Therefore, in a predictive sense, a higher investment rate would

translate into a smaller probability of a fiscal crisis, the opposite of what was

found in model 1. In model 3 the sign is negative as expected, but the

variable was no longer significant. One possible explanation is related to a

large amount of investment spending undertaken by Rio de Janeiro for the

2016 Summer Olympics, even when they were already financially constrained.

In model 2 only Current liabilities / Cash and cash equivalents was significant

at a 5% level. In model 3, that excludes only Current liabilities / Cash and

cash equivalents with respect to model 1, several variables were significant.

Gross debt / Net current revenue and Primary balance / Debt service were

significant at the 5% level while Current expenses / Current revenue and

Compensation of employees / Net current revenue at the 10% level. Because

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of this drastic change of the significant explanatory variables in going from

model 1 to model 3, it does raises concerns about an omitted variable bias

in model 3.

In order to better grasp which model is in some sense better, we can con-

duct a likelihood-ratio test described in section 3.2. First, likely due to the

bias-reduction method employed, the log-likelihood for model 2 is, in fact,

greather than the log-likelihood for the unrestricted model 1, meaning that

there was a likelihood gain moving from imposing the parameter restric-

tion. For model 3, the test statistic is LR = 2 · (−5.964 + 8.246) = 4.56.

Compared with a χ2 with one degree of freedom, the p-value is equal to 0.033.

We, therefore, reject the null hypothesis at a 5% significance level, meaning

that the loss of likelihood in imposing the restriction is likely different from

zero and the unrestricted model (model 1) should be considered the best one.

Together, these results indicate that in choosing between the information set

of the current versus the newly proposed methodology, the newly proposed

methodology appears to be the better choice.

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Testing up

Table 4.2 presents the regression estimates for the “testing up” approach.

Model 1 (Model 2 in table 4.1) is the base model that uses the fiscal ratios

proposed in the new payment capacity evaluation as explanatory variables.

We first ran individual simple regressions against each of the fiscal variables

set forth in the Finance Minister Decree n 306, 10/09/2012. The ratios Debt

service / Net current revenue, Compensation of employees / Net current

revenue and Gross investment in nonfinancial assets / Total expenditure

were significant in the individual regression. We then added the ratios to

the base model. This is reported in models 2 through 4 in table 4.2. Debt

service / Net current revenue (Model 2) was not significant and didn’t change

the sign of the other explanatory variables. Compensation of employees /

Net current revenue (Model 3) was also not significant, but with its inclusion

in the model Current expenses / Current revenue was significant at a 5%

level. The sign, however, was somewhat puzzling. It indicates that holding

compensation of employees fixed, lower savings reduces the probability of

a crisis. There are no readily available explanations for this result except

for the observation that Compensation of employees is the most significant

component of current expenses in all states. Gross investment in nonfinancial

assets / Total expenditure was (Model 4) was not only significant at the 10%

level, but made Gross debt / Net current revenue significant as well at the

same level. The sign was again positive, implying that higher investment is

correlated with higher probability of a fiscal crisis.

We finally add Compensation of employees / Net current revenue and

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Gross investment in nonfinancial assets / Total expenditure to the base model

(Model 5) giving what can be considered the final specification of the “testing

up” strategy. In this model Current liabilities / Cash and cash equivalents

and Gross investment in nonfinancial assets / Total expenditure were signif-

icant at the 5% level. We again conduct a likelihood ratio test to compare

the unrestricted model (model 5) with the restricted one (model 1). The test

statistic is LR = 2 · (−4.063 + 5.804) = 3.48. Compared with a χ2 with two

degrees of freedom, the p-value is equal to 0.175. We, therefore, fail to reject

the null hypothesis. The interpretation is that it might be the case that the

loss of likelihood by excluding the two variables from the unrestricted model

is not different from zero. Again this indicates that restricting the informa-

tion set to the fiscal indicators of the newly proposed methodology appears

to be a reasonable choice.

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Chapter 5

Conclusion

The purpose of the current study was to evaluate the statistical and practical

significance of both the current and the newly proposed fiscal indicators used

by the National Treasury Secretariat (NTS) to assess the payment capacity

of subnational governments in Brazil. The current methodology enacted in

2012 by the NTS was deemed to be overly complicated in general and also

based on a set of fiscal indicators that could potentially be simpler in terms of

dimensionality without harm in terms of predictive performance. This view

was justified on the basis of the correlation between the fiscal indicators.

This study has identified that the new methodology that uses only 3 ratios

instead of the 8 of the current methodology is in fact statistically superior

in terms of the likelihood of the given data. This superior performance is

mostly attributed to the ratio Current liabilities / Cash and cash equivalents

who proved itself to be significant in all specifications employed in this study.

Expressing these results in the language of the concepts related to fiscal

sustainability discussed in section 2.1, we can say that empirically, the will-

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ingness and ability to pay of an SGN in Brazil appear to be mostly explained

by its liquidity position. Solvency ratios appear to be only instrumental for

this explanation, in the sense that they matter only to the extent that in-

directly they influence the trajectory of liquidity ratios. To exemplify, high

debt ratios to net current revenue can only explain fiscal crisis episodes in

Brazil to the extent that debt service obligations generate higher current

liabilities.

The research has also shown that for the sample at hand, the fiscal indi-

cators proposed in the new methodology proposed by the NTS could maybe

fruitfully include Gross investment in nonfinancial assets / Total expenditure.

However, this result appears to be more related to the observed behavior of

Rio de Janeiro, who, even in financial difficulties, kept investment rates high

because of the commitments made with the 2016 Summer Olympics.

There are four major sources of weakness in this study, all in some way or

another related to data constraints. First, we did not allow for the presence

of unobservable heterogeneity between states, by using, for example, a fixed

effects logit model. The reason for this is simply that in fixed effect estimation

all the observations corresponding to states that did not face a crisis episode

in the sample horizon would be dropped out of the likelihood function, leaving

only the observations of Rio de Janeiro, Rio Grande do Sul and Minas Gerais.

The second source of weakness is related to the definition of fiscal crisis

episode adopted. The enactment of a decree of financial calamity is a politi-

cal process that a given state might not participate because it does not align

with the political calculus of the politicians involved in this decision. Al-

though this sounds like a tautology, it is especially important in the current

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case. The reason is that the most common interpretation of the Brazilian

legal system, shared by the Ministry of Finance1 , says that the decree of

calamity should be restricted to natural disasters, and therefore the benefits,

such as the possibility to delay payments to creditors and to bypass some

legal requirements for procurement and budgeting process, is not valid under

“financial calamity”. A more reliable definition of fiscal crisis episode would

need to make use of arrears data that still do not exist for SGN’s in Brazil.

A third source of weakness comes from the 2008-2016 horizon employed.

Brazil experienced in the 80s and 90s repeated fiscal crisis of subnational

entities with three rounds of debt restructurings. These should clearly be

considered a fiscal crisis episode. However, the majority of the explanatory

variables used in this study were fiscal variables and indicators derived from

the datasets provided by the National Treasury Secretariat. Although, the

original period covered by the data published by NTS extends from 1986

through 2016, totalling 31 years of data, events like hyperinflation, change

of currencies, change in fiscal reporting and budget classifications and no

tracking of stock variables makes the process of compiling a cleaned and

consistent dataset a research enterprise of its own.

Finally, because there were only three fiscal crisis episodes in the sample

that happened in the same year, it was not possible to look into out of sample

forecast accuracy measures, which are ultimately the final yardstick by which

EWS models should be judged. (Berg et al. 2005).

Putting the need for the collection of a more comprehensive dataset of

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http://g1.globo.com/bom-dia-brasil/noticia/2016/12/

calamidade-financeira-de-estados-nao-e-reconhecida-pelo-governo.html

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fiscal variables on SGN aside, the cited weakness of this study are useful

alternatives for future work. Additionally, because most of the EWS liter-

ature is currently focused on sovereign countries, studies that use different

strategies in the three areas that tend to differentiate early warning systems

models, namely, the definition of the crisis event, the statistical methodology

employed, and the set of explanatory variables, but applied to SGNs, would

be a welcome addition to the literature.

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