SUMMARY

Ágnes Vidovics-Dancs

SOVEREIGN DEFAULTS

Ph.D. dissertation

Supervisor:
János Száz, CSc.

Professor

Budapest, 2015
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1. Research Background and Topic Choice

The fact that I have worked for the Hungarian Government Debt Management Agency for almost two years between 2005 and 2006, and thereby I had the chance to get to know a number of – primarily risk management – aspects of debt management both in theory and in everyday practice has made a great impact on the choice of my doctoral field of research. Besides, my master’s thesis was also inspired by this topic, I focused on the possibility and risks of issuing a special government debt instrument, namely the inflation-linked bond. Furthermore, I participated in the National Scientific Students’ Associations Conference where my paper based on this topic was awarded with first prize in the respective section.

My primary goal at the beginning of the doctoral program was, within the wider field of government debt management, to model the optimal composition of debt portfolio. The trends and events in global economy, however, have drifted a second area into my horizons, that came not exclusively to my sight but also to the world’s: a more and more frequent discussion has started on the phenomenon of sovereign defaults. Once a dear colleague of mine gave me the book of Carmen Reinhart and Kenneth Rogoff titled This time is different, then I have made my final decision on the financial-economic phenomenon called sovereign default to be put in the focus of my doctoral thesis. Nevertheless, I also was surprised on myself being led back by this research topic to the inflation-linked bonds after almost a decade, shedding light on those instruments from aspects I was not even aware of when writing the my master’s thesis.

The dissertation is organized as follows. The first chapter presents the main features of government bonds and their markets. The purpose of this chapter is twofold. First, the relevance and significance of sovereign defaults
as research topic is emphasized by presenting government bond markets as the scene of buying and selling potential sovereign defaults. Second, the traditional interpretation of government bonds as simple and boring securities is criticized.

The second chapter deals with conceptual questions of sovereign default. Besides presenting received definitions of international rating agencies, I also shed light on the elements of the definition in general. This is important because common definitions of default are convenient, but might obscure the fact that beyond debts a sovereign state has many other types of liabilities as well.

The third chapter briefly outlines the history of sovereign defaults. I will show that such events occurred more frequently and in more countries than one might think - not only in South America, not only after military coups, not only in foreign currency.

The fourth chapter is dedicated to systematize sovereign defaults, while the fifth chapter analyses the costs of sovereign defaults. Creditors of sovereign states – unlike those of private companies – have very limited legal possibilities to enforce debt repayments. Consequently, it is not enough to ask why sovereign defaults occur. A less common question is to be asked as well: Why do sovereign states repay their loans, why do not they default? It is widely accepted in the literature that the existence of sovereign debt is provided by the costs of default. By reviewing and systematizing the possible cost types, and by exploring the inconsistencies in the related literature, I will show that we do not know exactly the mechanisms ensuring the existence of sovereign debts.

In the sixth chapter I analyse the relationship between sovereign defaults and the inflation-linked bonds. My premise is that the default risk of real obligation exceeds the default risk of nominal ones.
In the last chapter, I indicate further research topics to be analysed, and then summarize the result of the dissertation.

Summarising, the dissertation seeks the answer for the following questions:

1. Is there a unique definition for sovereign defaults? If not, what are the possible definitions, and what are the ingredients that all definition has to comprise?
2. What are the types of sovereign defaults? From which aspects it is worth to classify the default events?
3. Why do sovereign states repay their loans, why do not they default? Why the literature could not provide a consensual answer to this fundamental question?
4. What is the relationship between the default risk of nominal and real bonds? If there is a theoretical difference between them, is it reflected in market data?
2. Research Methodology

In the different chapters of the dissertation either qualitative or quantitative methods and tools are being applied with respect to the traits of the research question in focus.

In the first chapter of the thesis, upon the organization and analysis of individually collected statistical data it is being introduced how significant the treasury bond markets are, which, out of the financial markets are the ones closely related to the phenomena of sovereign defaults.

Therefore, the chapter on the one hand underpins the practical relevance of the topic choice, on the other hand it draws the attention to the fact that although government bond markets represent the opinions and expectations of investors in relation to a certain sense of sovereign defaults, they do not tell much about the causes, consequences, and further attributes. The third chapter highlights the repeated timeliness of the topic, furthermore supports the importance of understanding the wider context. In this chapter I outline the history of sovereign defaults based upon historical factual data showing that sovereign default events happen often, in several ways, and under different conditions.

In the second, fourth, and fifth chapters of the thesis basically aim at finding answers for questions that are subjects of qualitative analyses, inter alia the examination of the univocality of the sovereign default concept, or the typology definition possibilities of the latter. Here, from this aspect the methodology of making and analysing case studies take over. In the aforementioned chapters a broad and in-depth literature review was carried out, the results relevant to my research questions are not solely presented, but are also confronted to each other and are put on a common platform.
As a result of the analyses a number of causes and explanations are identified and formulated in order to the contradictions in the literature be resolved.

The earlier chapters ground the conceptual system and theoretical framework, without which in chapter six it would not have been possible to discuss a narrower problem, i.e. the relationship of inflation-indexed bonds with sovereign defaults in a trustworthy way.

As a first step, I show formally, how unexpected inflation and partial default scenarios could be compared as scenarios resulting in decreased real ex-post returns. With the help of the formal relationships, I illustrate the indifference curves of the two scenarios. Afterwards, I identify the factors that might influence the difference between nominal and real bonds’ yields, the so called break-even inflation. Based on the previous conclusions of the dissertation, the break-even inflation is decreased by the default risk premium difference of the nominal and indexed bonds. With the purpose of testing the appearance of this difference in market data, I estimate an econometric model on USA Treasury’s break-even inflation time series. I used an autoregressive model which allows for volatility to cluster, and among the possible specifications a chose an AR(4)-GARCH(1,1) model. For error distribution of the variance equation, I assumed t-distribution. The estimation results and the goodness of the model are tested with usual methods: among others, I tested the serial correlation of the residuals and the squared residuals, the distribution of the residuals and the significance of the estimated parameters.
3. Results of the Dissertation

The results of the dissertation are structured as to follow the questions presented in Chapter 1, respectively.

1. The abstract concept of sovereign defaults, and the consequences of such a default might have been clear and obvious in the past, but the concept is rather manifold than unique today.

1.a. The most general – and the least concrete – definition of sovereign default is that a country does not fulfil its financial obligations. In accordance with this, I identified two ingredients that all default definition should contain: it has to be clarified which obligations are to be considered and what ‘not fulfilling’ means. However, nor of these ingredients is obvious if the debtor is a sovereign country. This finding sheds light on several inconsistencies in the literature. For example, if we take the common definition, where obligations are exclusively debt instruments, then most of the sovereign defaults have much more strategic aspect than it is usually discussed.

2. When preparing a classification of sovereign defaults, I identified four factors that describe the main features of default events. These factors characterize the size and type of debt affected; furthermore the way and reason of not servicing the debt. It is easy to see that these four aspects are closely related to the ingredients of defaults’ definition presented in the previous point. In the dissertation, I determined different default groups according to all the four factors, and I also analysed why these groups are worth to be separated. My own classification is presented in Table 1.
Table 1. Classification of sovereign defaults

<table>
<thead>
<tr>
<th>Principle of classification</th>
<th>Possible types</th>
</tr>
</thead>
</table>
| Size of default             | • Total/partial  
                             |   • Groups by the absolute/relative size of debt affected  
                             |   • Groups by the size of creditor losses  |
| Type of debt affected       | • Local/foreign currency debt  
                             |   • Domestic/external debt  |
| Form of not fulfilling      | • Missed payment  
                             |   • Delayed payment  
                             |   • Distressed debt exchange  |
| Reason of not fulfilling    | • Inability to pay: illiquidity, insolvency  
                             |   • Unwillingness to pay: repudiation, strategic decision  |

3. For the question, ‘Why do countries repay their loans?’ the common answer is ‘Because default has costs’. However, there is no consensus about which type of costs is dominant or how to measure these costs. I identified the following reasons behind the contradictions in the literature.
3.a. The forms of the defaults’ costs are changing in time: centuries ago, and even at the beginning of the 20th century it was usual that a sovereign default triggered military actions. Today, even the exclusion from financial markets is not necessarily experienced after a default.

3.b. Most of the empirical studies, especially in case of the so-called reputational costs, do not separate properly the two main dimensions of costs. The dimensions I determined are the markets influenced by the costs and the mechanism of their emergence.

3.c. Most of the empirical studies do not differentiate among default events in the dimensions I determined during the classification of defaults, and hence they examine a rather heterogeneous sample.

4. If we approve the common argumentation that sovereigns are less risky in their domestic currency, partly because of their power to print money, then the default risk of inflation-indexed bonds must be higher than that of nominal bonds. From the point of view that the obligation cannot be eased via inflation, indexed bonds are akin to bonds issued in foreign currency.

4.a. For an investor, unexpected inflation might cause similar losses in ex-post real return than partial default. This finding leads us back to result 1.a. in the sense that different default definitions determine different analysis frameworks. In case of zero-coupon type investments, the relationship between unexpected inflation
and partial default leading to the same ex-post real return is the following:

\[ D = 1 - \left( \frac{1 + \pi^e}{1 + \pi^e + \pi^u} \right)^T = 1 - \left( \frac{\pi^u}{1 + \pi^e + \pi^u} \right)^T \]

where
- \( D \) = rate of partial default
- \( T \) = maturity
- \( \pi^e \) = annual expected inflation
- \( \pi^u \) = annual unexpected inflation

4.b. Apart from expected inflation, inflation premium, and liquidity difference, break-even inflation may comprise default risk difference as well. Like liquidity difference, default risk difference decreases the break-even inflation and hence makes a negative bias as compared to inflation expectations. Formally:

\[ BEI = IE + IP - (DP_r - DP_n) - (LP_r - LP_n) \]

where
- \( BEI \) = break-even inflation
- \( IE \) = inflation expectations
- \( IP \) = inflation premium
- \( DP \) = default premium
- \( LP \) = liquidity premium
- \( r \) = index denoting real bond
- \( n \) = index denoting nominal bond
4.c. Empirical results drawn from analysis on USA Treasury bond markets’ time series suggest that the default risk difference appear in the markets as well: after controlling for inflation and liquidity effects, CDS-spreads that represents default risks, have significant effect in the dynamics of break-even inflation. The estimated model was the following AR(4)-GARCH(1,1) specification:

\[ dBEI_t = \beta_1 dIS_t + \beta_2 dCDS_t + \beta_3 dBAS_t + \]
\[ + \beta_4 dBEI_{t-1} + \beta_5 dBEI_{t-2} + \beta_6 dBEI_{t-3} + \beta_7 dBEI_{t-4} + u_t \]
\[ u_t = \sqrt{h_t} \nu_t; \]
\[ h_t = \alpha + \gamma_1 u_{t-1}^2 + \gamma_2 h_{t-1}; \]

where
BEI = break-even inflation
IS = inflation swap rates
CDS = CDS-spread
BAS = difference between bid-ask spreads of real and nominal bonds
d = denotes percentage change.

The estimation output is summarised in Table 2.
Table 2. Estimation output

Dependent Variable: DBEI
Method: ML - ARCH (Marquardt) - Student's t distribution
Sample (adjusted): 6 813
Included observations: 808 after adjustments
Convergence achieved after 13 iterations
Presample variance: backcast (parameter = 0.7)
t-distribution degree of freedom parameter fixed at 4
GARCH = C(8) + C(9)*RESID(-1)^2 + C(10)*GARCH(-1)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>z-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIS</td>
<td>0.8810</td>
<td>0.0231</td>
<td>38.1976</td>
<td>0.0000</td>
</tr>
<tr>
<td>DCDS</td>
<td>0.0076</td>
<td>0.0043</td>
<td>1.7689</td>
<td>0.0769</td>
</tr>
<tr>
<td>DBAS</td>
<td>-0.0011</td>
<td>0.0007</td>
<td>-1.6462</td>
<td>0.0997</td>
</tr>
<tr>
<td>AR(1)</td>
<td>-0.3368</td>
<td>0.0338</td>
<td>-9.9672</td>
<td>0.0000</td>
</tr>
<tr>
<td>AR(2)</td>
<td>-0.1651</td>
<td>0.0362</td>
<td>-4.5599</td>
<td>0.0000</td>
</tr>
<tr>
<td>AR(3)</td>
<td>-0.0283</td>
<td>0.0355</td>
<td>-0.7987</td>
<td>0.4244</td>
</tr>
<tr>
<td>AR(4)</td>
<td>-0.0924</td>
<td>0.0340</td>
<td>-2.7141</td>
<td>0.0066</td>
</tr>
</tbody>
</table>

Variance Equation

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>z-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.0000</td>
<td>0.0000</td>
<td>1.9281</td>
<td>0.0538</td>
</tr>
<tr>
<td>RESID(-1)^2</td>
<td>0.1014</td>
<td>0.0264</td>
<td>3.8412</td>
<td>0.0001</td>
</tr>
<tr>
<td>GARCH(-1)</td>
<td>0.8940</td>
<td>0.0250</td>
<td>35.8024</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

R-squared 0.4861 Mean dependent var -0.0002
Adjusted R-squared 0.4822 S.D. dependent var 0.0144
S.E. of regression 0.0104 Akaike info criterion -6.6178
Sum squared resid 0.0864 Schwarz criterion -6.5597
Log likelihood 2683.6102 Hannan-Quinn criter. -6.5955
Durbin-Watson 2.0820
Thus, the estimated relationships are:

\[
\text{d} \text{BEI}_t = 0.88 \text{d} \text{IS}_t + 0.008 \text{d} \text{CDS}_t - 0.001 \beta_2 \text{d} \text{BAS}_t - \\
- 0.337 \text{d} \text{BEI}_{t-1} - 0.165 \text{d} \text{BEI}_{t-2} - 0.028 \text{d} \text{BEI}_{t-3} - 0.092 \text{d} \text{BEI}_{t-4} + u_t
\]

\[
u_t = \sqrt{h_t} v_t;
\]

\[
h_t = 1.74 \times 10^{-6} + 0.101 u_{t-1}^2 + 0.894 h_{t-1};
\]

As an analysis and interpretation of the results we may observe that in the mean equation the coefficients of the explanatory variables responsible for the inflation, liquidity and default risk effects are all significant at 90 percent significance level. Among these variables, the most important in explaining the variance of the break-even inflation is the inflation swap rate. This is not surprising, the positive sign of \( \beta_1 \) and its value close to 1 are in accordance with the close relationship between break-even inflation and inflation swap rates.

The value of \( \beta_2 \) and \( \beta_3 \) (in absolute terms) are much lower and hence the liquidity and inflation effects appear to be less important. Unfortunately, the sign and the exact value of the coefficient \( \beta_2 \) are cannot really be interpreted or explained, since the CDS-spreads are not measuring the default risk difference, they only represent the aggregate default risk premium of the nominal and the real bonds. The negative sign of the coefficient \( \beta_3 \) is a plausible result, but its value cannot be interpreted as exact liquidity premium, since bid-ask spreads are only one possible measures of liquidity. However, the scope of the analysis was not
measuring the liquidity and the default risk differences, but to
demonstrate their existence.

Analysis of the variance equation should be started by observing
that the sign of each coefficient is positive, which is a prerequisite
for the conditional variance to be nonnegative, thus for the
GARCH-specification to be reasonable. The fact that the sum of
the ARCH- and the GARCH- coefficients is close to one
suggests that shocks die out very slowly, which is a common
feature in financial time series. All in all, the GARCH(1,1)
specification shows that the volatility of the dBEI variable
depends on the volatility of the previous period, and implicitly on
earlier volatilities as well.

Explanatory power of the model with R²-value at around 48
percent is rather moderate. This is in line with expectations, since
the liquidity and default effect are only represented and not
measured exactly in the specification.

Summarising the results of this chapter, they are not
contradictory to my expectations, that besides inflation and
liquidity effects, market break-even inflation may comprise the
default risk difference as well.
4. Questions for Further Consideration

Taking the results of the thesis into account the following further research directions could be identified. As a result of the examination of the definition issues around sovereign default it was concluded that the definition of the default event is not unambiguous at all. To put it the other way around, between default and non-default there is no clean-cut borderline. Sovereign default as a concept goes through an evolution just as the concept of money. Money used to be identifiable with gold or other precious metals. Nowadays, we differentiate monetary base and other monetary aggregates; cash and quasi-money, and so forth. It is worth further researching the following questions: What would the levels of sovereign default be? What would the near-defaults be? When and under what circumstances the expert’s opinion would consider a country to be on the brink of sovereign default?

The relationship between inflation-indexed bonds and sovereign defaults might also be a subject for further consideration. The existence of default risk difference between nominal and real bonds could also be examined in other periods or markets, thereby extending the research in space and time. It would be desirable – however more complicated – to measure that effect. Beyond the decomposition of break-even inflation, the problem could also be captured by looking into the connection between the general default risk of some country and the weight of its inflation-indexed debt in the debt portfolio. It is linked to the latter train of thought that inflation risk does not only change in the case of inflation-indexed debt, but also when joining a monetary union. Will the default risk increase when joining such a union? Will the inflation risk partially be transformed into default risk? Those questions might become particularly interesting for a candidate country and for its creditors as well.
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The dissertation has 73 references. From the point of view of the results and the main findings, the most important references are the following.


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6. Author’s Bibliography

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