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Essays on Government Debt Financing Costs

Ph.D. Dissertation

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1. The aim of the dissertation and the theoretical background

In the recent years, more and more countries had to face the problem that their government debt / gross domestic product quotients' dynamics were not sustainable. The most important factors in this process were smaller growth, bad structural balance of the budget, and high financing costs of the government debt, which is related to the increasing sovereign yields. These three factors are closely related, but we can highlight that on the one hand, raising the growth rate and balancing the budget could be done by using either different (for example positive fiscal stimulus vs. fiscal tightening) or very unpopular measures (like making more flexible working laws, or raising the retirement age). On the other hand, it might be possible to reach success by decreasing the sovereign yields.

The primary market of government bills and bonds is one of the most important fields where financing costs of government debt are evolving. The primary market affects financing costs through the selling price of government bills and bonds. These securities are in many cases – as for example in the case of domestic papers in Hungary - sold through auctions. Nowadays, two auction techniques (discriminatory and uniform-price auctions) are most commonly used for the sale of securities, specifically government bills and bonds. Since the selling price of the papers is influenced by the technique of the auction, a comparison of the discriminatory and uniform-price auctions would be helpful to determine which of the two most commonly used auction formats is the better allocation mechanism under given conditions.

The financing costs of the government debt are also strongly related to the country's credit risk premium, measured mostly through sovereign CDS spreads. This has two reasons. First, the foreign currency denominated bond yields can be decomposed to a risk-free yield (like the sovereign German Euro-yield or the USA Dollar-yield) and the rest of the bond yield, which is called bond spread. The bond spread is generally near to the CDS spread, and CDS spreads tend to lead bond spreads (Alper et al. [2012]; Varga [2009]). Second, in the case of domestic bonds, the credit risk of the country also has a significant effect on yields on the longer terms. The credit risk premium of the local currency denominated bonds might be somewhat different from CDS spreads, but CDS spreads have a significant co-movement with long term domestic yields (Monostori [2012b], Monostori [2013e]). While sovereign credit risk and CDS spreads are very actual topics also in academia, our research question has some

traditional background. Part III's objective is to empirically assess the role of country-specific fundamental determinants in shaping Eastern European relative CDS spreads.

Part IV is an application of the model to the Hungarian CDS spreads. In this case study we identify the country-specific determinants of the last years' processes of Hungarian CDS spreads.

2. Methodology

The expected revenue of uniform-price and discriminatory auctions cannot be ranked definitively based on analytical studies; therefore it may be appropriate to approach this issue on an empirical basis. The empirical evidence of real-world auctions provide a robust answer to the question of expected revenue; the uniform-price format coming out as more beneficial for the Treasury. Experiments fall into two categories: in the first case, comparison is enabled by the fact that the auction format of identical goods was changed from a given time, while in the other case, there were other treasuries to auction different products in a close-to-identical time interval with different methods. However, all experiments have been plagued by the identification problem, that is, the change caused by the auction method is difficult to tell apart from the effects of other circumstances. It would be a real scientific breakthrough, though, to set up a real-life experiment in which the same product would be sold simultaneously in both uniform-price and discriminatory auctions. Even though fewer conclusions could be drawn than in the previously proposed arrangement (due to the repetition of auctions), it would be instructive to see an experiment where primary market actors have to submit bids for both auction formats, then the real format would be decided by drawing lots. We should note, however, that the experiment may increase the 'fog of war', i.e. the strategy space may become even more complicated and the number of possible equilibria may increase to extreme heights. Such an experiment could be a very important step in future work; however, it has to be supported by a bond issuer.

Hence, in Part II our methodology is a comparative analysis through the relevant literature about discriminatory and uniform price auctions. The same methodology is used by such important papers in this topic as Das & Sundaram [1997]; Binmore & Swierzbinski [2000], or in Hungary (Szatmári [1996b]), and the most recent Hungarian study of this subject, (Kondrát [1996]). The latter Hungarian papers focused primarily on models based on the unit demand assumption; whereas researchers have demonstrated that these findings are often not applicable to all of the multi-unit auctions, so a new review might be reasonable. I will examine the following hypotheses:

H1: We can give an accurate answer to the question, whether the uniform price or the discriminatory auction format is the better allocation mechanism under given conditions in Hungary.

In Part III we take the traditional and simple methodological approach of Edwards ([1983]; [1985]) and a wealth of publications since to date. We adhere to the literature in assuming that most of the time series variation in CDS spreads are a result of common shocks to the pricing of risk and we concentrate the analysis on the other, cross-sectional aspect of CDS spreads by assessing which fundamental factors have been empirically important in explaining the relative riskiness of countries as proxied by the relative magnitude of these indicators. In terms of estimation methodology we use a time fixed effects panel regression on both the levels and changes of spreads and fundamental variables. We link the short-run dynamics with the relationship between variable levels through an error-correction term.

H2: Contrary to the assumptions of efficient markets, rational investors and the absence of arbitrage opportunities, which would imply immediate adjustment of spreads to newly available fundamental information, changes in fundamental variables mainly affect CDS spreads gradually, through an error-correction mechanism.

We lay emphasis on using a dataset that treats some empirical issues that, in previous studies, have often been disregarded. First, we use projections of future variables instead of actual data where possible. CDS spreads (and bond spreads) derive from expected future cash flows during the tenure of the instrument. Therefore it is arguably the expectations of the variables influencing credit spreads (growth, budget balance, etc.) and not the actual data available at the time that matters. Using actual data instead of expectations introduces a source of error, and it will contaminate inference on how the variable affects spreads. This error will be larger for variables whose expectations are in general more volatile. Also, a mistake can be made in assessing the explanatory power of macroeconomic variables when comparing their actual data with financial time series. Though macroeconomic variables change (or are observed) infrequently, while financial indicators fluctuate on high frequency, it may be the case that the expectation of macroeconomic variables is just as volatile as the financial time series and that this explains more of the latter's variation than actual data. Second, we aim to reduce the adverse effects of variable omissions by including a larger and conceptually wider set of fundamental variables than usual in similar studies. Besides the

standard macroeconomic variables, we incorporate data on the banking sector and use a set of political and institutional variables as well.

H3: Besides the standard macroeconomic variables, data on the banking sector and institutional-political variables are also important in the relative credit risk premium of a country.

Principal components and factors are extracted from conceptually similar variables' groups and these are then used in CDS spreads' regressions to overcome problems of multicollinearity and the curse of dimensionality. To further limit adverse effects of variable omission, we attempt to make use of the extra information contained in credit ratings compared to that in our fundamental variable set.

Although we do not explicitly incorporate cross-section and time period heterogeneity of fundamental variables' effects in our baseline model, we do check the robustness of our general results on subsamples. Also, regressions are re-estimated on shorter time windows to gain an intuition on how coefficients have evolved through time.

H4: Some of the fundamental variables' impacts are time-varying.

In Part IV we apply the model from Part III to Hungarian data. We use simple descriptive statistics to analyze the latest developments. To quantify the two distinct effects on the relative Hungarian CDS spread, i.e. the worsening of fundamentals and the shift in investor preferences (the wake-up call effect), we use the Oaxaca-Blinder decomposition (Blinder [1973]; Oaxaca [1973]). Applied to our context the Blinder-Oaxaca decomposition separates the effect of changing parameters, $\beta_{p2} - \beta_{full}$, and changing variables, $X_2 - X_1$, so that:

$$CDS_{p2} - CDS_{full} = \beta_{p2} * X_2 - \beta_{full} * X_1 == \beta_{p2} * X_2 - \beta_{full} * X_1 - \beta_{full} * X_2 + \beta_{full} * X_2 == \left(\beta_{p2} - \beta_{full}\right) * X_2 + (X_2 - X_1) * \beta_{full} \quad \textbf{(1)}$$

where β_{full} and β_{p2} denote the full sample and the second period (2010-2012) estimates, X_1 and X_2 stand for fundamental variable values in March 2012 and January 2010, respectively.

In particular we decompose the difference between the model-implied value for March 2012 due to the 2010-2012 period estimates and the model-implied value for January 2010 due to the full sample estimates.

H5: Not only the fundamental changes, but also changes in investor preferences led to the relative worsening of Hungarian CDS spreads.

3. Results

3.1. H1: We can only give partial answer to the question in H1; the answer depends on the utility function of the issuer.

In Part II, theoretical models arrive at different rankings for expected revenue; however, they do reveal the relationship between the bids submitted and the auction technique. These results are confirmed both by 'laboratory' experiments and the empirical evidence of real-world auctions. The latter may also provide a robust answer to the question of expected revenue; the uniform-price format coming out as more beneficial for the Treasury. Still, at present the global majority of issuers of government bonds use the discriminatory-price format and central bank instruments also tend to be sold in this format. This is because issuers may have considerations other than expected revenue.

The main advantages of the uniform price auction method might be: higher expected revenue, low markup between the market price and the auction price (in the long run on average), and increased participation in the auctions.

The discriminatory auctions are able to reduce volatility, reveal the true valuations better, and hinder price-manipulations.

We can only give partial answer on the question in H1. Even though studies of auction formats tend to focus on the effect on expected revenue, the issuer may have a number of other motives and the considerations to be used to optimize the choice are far from clear. Because the utility function of the issuer is not clear, we cannot give an accurate answer to which is the better formula in Hungary. However, we might have an idea if we pick the aspect on which the issuer should optimize. In the case of the auction of Hungarian government bonds, maximizing the expected revenue of the issuer may be important. If we accept that maximizing the expected revenue is the aspect on which the issuer should optimize, changing the auction format (or conducting an experiment into such a change) would be worthwhile if volatility remained persistently low with consistently high bid-to-cover ratios.

3.2. H3: We accept H3; banking stability and institutional-political background are significant.

In Part III we study the relationship between relative sovereign CDS spreads and a wide array of relative country-specific fundamentals on Eastern European data between July 2008 and March 2012.

We accept H3, since we find a significant effect not only on standard macroeconomic variables (growth expectations, government debt), but also on banking system stability and on the institutional-political background in the long-term relationship of relative CDS spreads.

Table 1. **Long-run regression results**

Dependent variable	Log CDS spread			Dependent variable	Log CDS spread		
Explanatory variables	coefficient	std.error	sign.	Explanatory variables	coefficient	std.error	sign.
PC_GROWTH*(-1)	0.253	0.015	***	PC_GROWTH*(-1)	0.253	0.016	***
F_BANK	0.310	0.015	***	F_BANK	0.303	0.015	***
F_EXTERN	0.148	0.015	***	F_EXTERN	0.121	0.017	***
F_GDEBT	0.211	0.016	***	F_GDEBT	0.203	0.017	***
PC_INST*(-1)	0.161	0.008	***	PC_INST*(-1)	0.154	0.009	***
FISCBAL*(-1)	-0.024	0.008	***	FISCBAL*(-1)	-0.023	0.013	*
RATING_RESIDUAL	0.068	0.012	***	RATING_RESIDUAL	0.068	0.012	***
Observations	405			Observations	405		
Periods	45			Periods	45		
Cross-sections	9			Cross-sections	9		
R-squared	0.853			R-squared	0.850		
adj. R-squared	0.832			adj. R-squared	0.829		
D-W stat.	0.165			D-W stat.	0.161		

*Note: For convenience, variables whose increasing values are consistent with CDS spread decreases (higher growth, better institutions, better fiscal balance) are multiplied by -1, so that their coefficients and t-statistics are aligned with other variables and CDS spreads. All equation coefficients are therefore expected to be positive. The right-hand panel uses a dummy variable's interaction with fiscal balance and external position for instruments in TSLS estimation. The dummy variable takes a value of 1 in the case of countries with relative good "stock-type" variables. Throughout the text we use the common notation for significances: * at 10 percent, ** at 5 percent, *** at 1 percent confidence levels.*

3.3. H2: We accept H2; changes in fundamentals affect CDS spreads not only immediately, but also gradually.

Table 2. **Short-run regression results**

Dependent variable	Log differences of CDS spread			Dependent variable	Log differences of CDS spread			Dependent variable	Log differences of CDS spread		
Explanatory variables	coefficient	std.error	sign.	Explanatory variables	coefficient	std.error	sign.	Explanatory variables	coefficient	std.error	sign.
d(PC_GROWTH*(-1))	0.084	0.031	***	d(PC_GROWTH*(-1))	0.068	0.033	**	d(PC_GROWTH*(-1))	0.080	0.029	***
d(F_BANK)	0.064	0.089		d(F_BANK)	0.026	0.093		d(F_BANK)	0.032	0.135	
d(F_EXTERN)	0.203	0.078	**	d(F_EXTERN)	0.191	0.084	**	d(F_EXTERN)	0.156	0.122	
d(F_GDEBT)	0.078	0.072		d(F_GDEBT)	0.045	0.079		d(F_GDEBT)	-0.189	0.107	*
d(PC_INST*(-1))	0.221	0.108	**	d(PC_INST*(-1))	0.204	0.116	*	d(PC_INST*(-1))	0.125	0.165	
d(FISCBAL*(-1))	0.015	0.013		d(FISCBAL*(-1))	0.011	0.014		d(FISCBAL*(-1))	0.021	0.020	
d(RATING_RESIDUAL)	0.023	0.036	*	d(RATING_RESIDUAL)	0.010	0.037		d(RATING_RESIDUAL)	-0.032	0.058	
ECM(t-1)*-1	0.110	0.020	***	log(CDS)(t-1)*(-1)	0.106	0.021	***	ECM(t-1)*(-1)	0.099	0.021	***
				PC_GROWTH(t-1)*(-1)	0.034	0.008	***	d(VIX)	0.012	0.002	***
				F_BANK(t-1)	0.027	0.009	***	d(VDAX)	0.003	0.003	
				F_EXTERN(t-1)	0.011	0.007		d(US_CREDIT)	0.001	0.000	***
				F_GDEBT(t-1)	0.026	0.007	***	d(USD/EUR)	1.324	0.168	***
				V_INST(t-1)*(-1)	0.013	0.005	***				
				FISCBAL(t-1)*(-1)	-0.008	0.003	**				
				RATING_RESIDUAL(t-1)	0.002	0.005					
Observations	396			Observations	396			Observations	396		
Periods	44			Periods	44			Periods	44		
Cross-sections	9			Cross-sections	9			Cross-sections	9		
R-squared	0.869			R-squared	0.872			R-squared	0.579		
adj. R-squared	0.850			adj. R-squared	0.850			adj. R-squared	0.566		
D-W stat.	2.003			D-W stat.	1.993			D-W stat.	2.027		

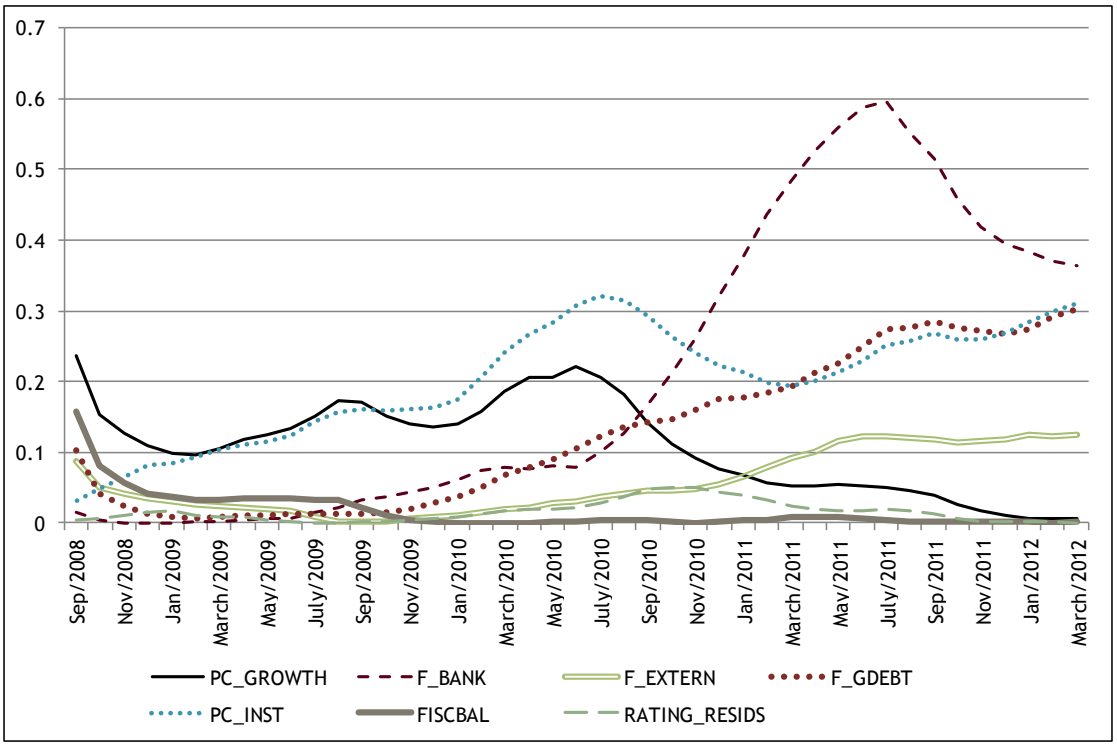
Note: For convenience, again, variables whose increasing values are consistent with CDS spread decreases (higher growth, better institutions, better fiscal balance) are multiplied by (-1), so a positive coefficient is expected everywhere in the table. The ECM, and lagged CDS spreads are also inverted this way, since originally a negative sign is expected that signals adjustment to the long-run equation. CDS spreads are taken as closing values on the 21st of each month (or the nearest trading day before), while Consensus Economics' projections are closed before this date in the middle of the month. Other regressors' values are taken at the end of the previous month.

We accept H2, since changes of the fundamental variables mainly affect CDS spreads gradually, through an error-correction mechanism.

Contrary to other studies we do not find higher fiscal deficit being associated with higher CDS spreads, which may be a result of reverse causality between credit risk and fiscal balance.

3.4. H4: We accept H4; some of the fundamental variables' impacts are time-varying.

Figure 1. **Explanatory power differences of restricted and unrestricted long-run regressions**



Note: 1-year rolling windows. Dates indicated are ending dates of the estimation window.

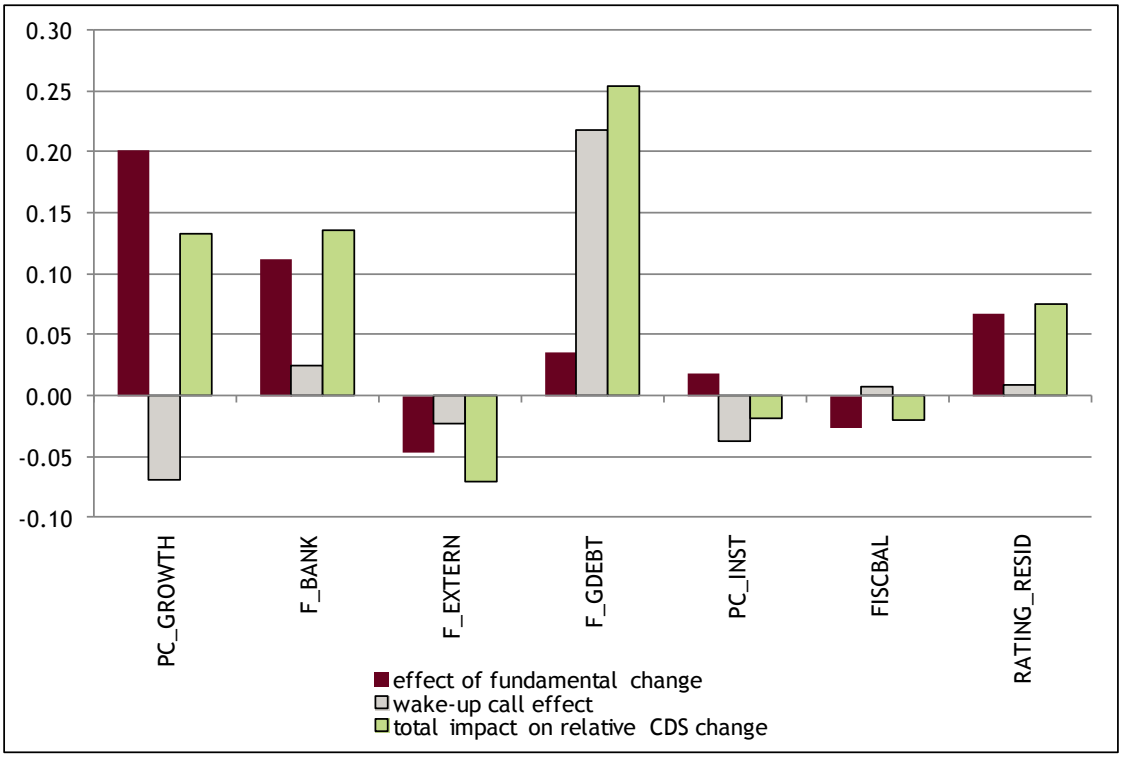
We accept H4: our results suggest that some of the fundamental variables' impacts are time-varying and imply relevance of the wake-up call hypothesis.

3.5. H5: We accept H5; the change in investor preferences had a significant effect on Hungarian relative CDS spreads.

In Part IV the model discussed in the previous chapter attributes to the Hungarian CDS spread's relative increase in response to both a worsening of fundamentals (growth prospects and banking stability) and to a changing in investor preferences: government debt, one of the country's key weaknesses, has become more important in relative sovereign risk assessment.

H5 can therefore be confirmed.

Figure 2. **Fundamental and wake-up call effects in changes of Hungarian spreads**



Note: Positive values are consistent with relative worsening.

3.6. Practice

While in Hungary, the Government Debt Management Agency (ÁKK) still uses the discriminatory format, a verification of the auction method might be particularly topical as, following similar steps by other treasuries, the public debt management agency of a country in the Central-Eastern-European region, Poland, switched to the uniform-price system in January 2012.

Since a decrease of only 1 basis point in the selling yields could spare the budget in the long term a significant amount yearly, this topic is important. As a very simple approximation for the effect on the expected revenue, we can state the following: the amount of the Hungarian Forint denominated government debt is approximately 13 000 billion HUFs (FX denominated debt is not allocated through auctions nowadays in Hungary: FX-bonds are allocated subscription-based at road shows, loans are naturally not auctioned). If another auction method could reduce the yields of the newly issued government debt, every basis point gained in the yearly yields could save around 0.01 percent for the state in the long term (when every previously issued paper ran out), that is ceteris paribus 1.3 billion HUFs yearly. Most authors have found a difference around 1-3 basis points between the revenue of the different auction methods[1]. The analysis may also be useful in reconsidering the form of auction for the central bank instruments introduced during the crisis and for the design of the format for the sale of any new instruments to be launched in the future.

Sovereign CDS spreads have received increasing attention in the past several years. The financial crisis of 2007-2008 and the ensuing sovereign crisis of the Eurozone periphery have increased activity in sovereign CDS markets and broadened the market's scope from emerging markets with large bond portfolios in the pre-crisis era to the smaller emerging markets and eventually to developed economy sovereigns. Market participants used the instrument to either take a speculative position on the credit risk outlook of sovereigns, or to hedge credit risk exposure through bonds; whereas analysts, central banks and the financial media observed the market to gauge the perceived credit risk of sovereigns.

[1] This might be on the one hand a significant amount for the state; on the other hand, this might be on the same order of magnitude as some distractions (like the change in liquidity premium which might also be affected by the changing market structure) or the estimation uncertainty.

In economic policy debates, it is an often argued point whether the change of sovereign CDS spreads was based on fundamentals in a volatile environment[2]. Our model is able to estimate a relative CDS spread based on fundamentals, so the spread between the model-based and observed CDS spreads might have important information content in these debates.

In our model some coefficients seem to be sensitive to the selection of the sample. Time-variation of parameters is supported by simple rolling regressions, pointing to an increase of government debt, banking stability and external balance in the assessment of relative riskiness of countries, which might be important in setting economic policy goals.

[2] Policy makers (also Monetary Council members) often argue that observed CDS spreads will tend to fundamental-based eqilibria in the long term.

3.7. Own publications

Part II was discussed at the November 15, 2012 meeting of the Monetary Forum, it has been presented at several conferences and it is published in Hungarian in the Közgazdasági Szemle (Monostori [2013c]) and in English in MNB Occasional Papers (Monostori [2014]).

The author also has other publications concerning government debt financing costs. Monostori [2012b] at Hitelintézeti Szemle is a paper about risk premia of government bond yields. Another paper at Society and Economy (Monostori [2013e]) is about sovereign bond market liquidity developments on the Hungarian market. While the article in MNB Bulletin (Erhart et al. [2013]) is not exactly about government debt financing costs, that topic (central banks' balance sheet strategies) is nowadays also related to the main topic of the dissertation.

Part III and Part IV were published only at conferences up to this moment (Kocsis – Monostori, [2013a]; Kocsis – Monostori, [2013b]); however, another output of the same research will be submitted in the upcoming weeks to Economics of Transition. These parts are results of a common research with Zalán Kocsis (and Zsolt Kuti also had some significant contributions).

Also some further conference publications are worth mentioning. (Monostori [2013a]; [2013b]; [2013d]; [2012a]; [2012c]; [2012d]; [2011a]; [2011b]; [2010]).

3.8. Structure

The structure of the dissertation is as follows.

Part I gives an introduction.

The main question of Part II is: which one of the most commonly used (discriminatory- and uniform price) auction formats has the more beneficial effect on government debt financing costs. This part starts with an introduction, which is followed by theoretical models. Next, empirical (both laboratory and non-laboratory) evidences are presented which is followed by the description of the international practice. The part is finished by summary and conclusions.

In Part III, the main question is: which fundamentals are the most important country-specific determinants of sovereign CDS spreads in Eastern Europe. After the introduction and literature review, data and methodology are described. Next, we present the general results, the variation of the most important factors in time and robustness checks. Finally, we conclude.

Part IV investigates the Hungarian sovereign CDS spread's developments through our model in the last few years. After introducing and presenting the stylized facts, model explanations for the deterioration are shown. Then we give explanations for the residuals of the model, and finally we conclude this part.

Part V gives a summary about the most important results of the dissertation.

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