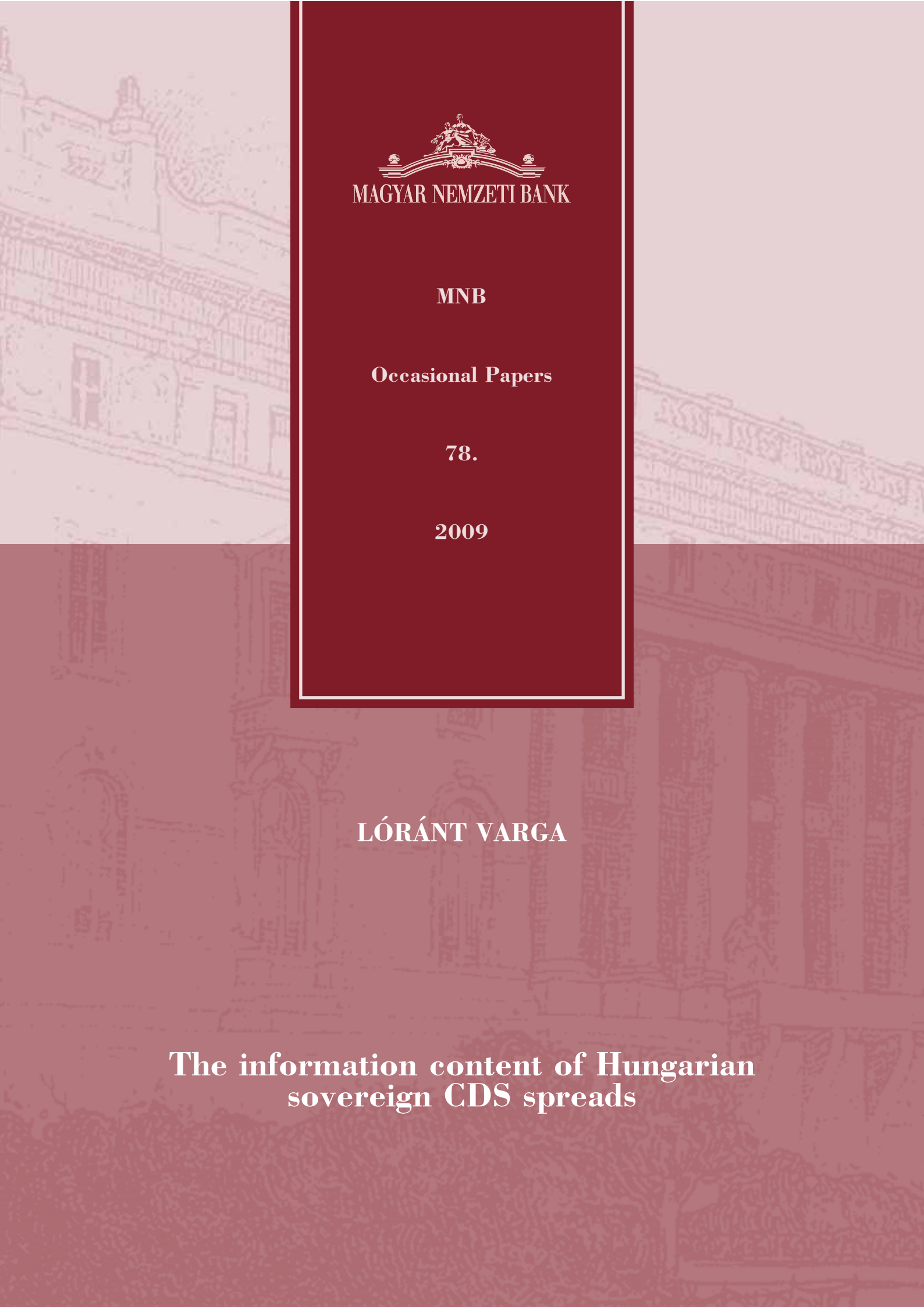


MAGYAR NEMZETI BANK

MNB

Occasional Papers

78.

2009

LÓRÁNT VARGA

The information content of Hungarian sovereign CDS spreads

The information content of Hungarian sovereign CDS spreads

May 2009*

* Cut-off date for data: June 2008.

Occasional Papers 78.

The information content of Hungarian sovereign CDS spreads

(A magyar szuverén CDS-szpredek információtartalma)

Written by: Lóránt Varga*

Budapest, May 2009

Published by the Magyar Nemzeti Bank

Publisher in charge: Nóra Hevesi

Szabadság tér 8–9., H–1850 Budapest

www.mnb.hu

ISSN 1585-5678 (online)

* I would like to thank the staff of the Financial Analysis Department for their valuable comments on the previous version of this paper. Special thanks to István Attila Veres (Money- and Foreign Exchange Markets Department, Magyar Nemzeti Bank) for the useful comments he provided when discussing the earlier version of the study, and to Jonathan Wolff (Quinnipiac University, Connecticut, USA) for contacting credit derivative brokers and market participants, and for organising the information they provided. Any remaining errors are mine.

Contents

Abstract

In our paper we present how the Hungarian *credit default swap* (CDS) market functions, and indicate its position in the global credit derivatives markets. Our primary goals are to glean some information from the CDS spreads about Hungary's credit risk, and to determine the role of the Hungarian sovereign CDS market in different market periods, as well as its long-term relationship with other Hungarian financial markets. Our findings suggest that the Hungarian market has low liquidity compared to the average liquidity of credit derivatives markets. However, relative to the outstanding stock of Hungarian sovereign foreign currency bonds, the daily average turnover of the market and the outstanding stock of Hungarian sovereign CDS contracts at the end of 2007 were substantial, estimated to be around EUR 10-20 million and EUR 7-20 billion respectively. Even though the Hungarian sovereign CDS spread and foreign currency bond credit spread tend to move in tandem in the long run, the two rates may temporarily deviate from one another due to micro structural factors. Hungary's credit risk premium is primarily defined in the Hungarian sovereign CDS market, which means that any new information pertaining to Hungary's credit risk is captured in the CDS spreads first. In contrast, the Hungarian foreign currency bond market is not an effective market, given that foreign currency bond credit spreads merely adjust to the changes of CDS spreads afterwards. During particularly turbulent market periods Hungarian sovereign CDS spreads tend to rise higher than is fundamentally justified.

JEL: F34, G12, G14, G15.
Keywords: credit derivatives markets, credit default swap, sovereign foreign currency bond markets, sovereign credit risk, credit rating, price discovery.

Összefoglaló

A tanulmányban bemutatjuk a magyar szuverén *credit default swap* (CDS-) piac működését és a globális hitelderivatív piacokon belül elfoglalt helyét. Elsősorban arra keressük a választ, hogy a megfigyelhető CDS-felárak milyen információt hordoznak a magyar állam hitelkockázatára vonatkozóan, milyen szerepet tölt be a magyar szuverén CDS-piac a különböző piaci periódusokban, és hosszú távon milyen kapcsolat köti össze más magyar pénzügyi piacokkal. Eredményeink alapján a hitelderivatív piacok átlagos likviditásához képest a magyar piac likviditása alacsony, azonban a magyar szuverén devizakötvények fennálló állományához mérten a piac 10-20 millió eurós becsült átlagos napi forgalma, és a magyar szuverén CDS-megállapodások 2007. év végi 7–20 milliárd eurós becsült fennálló állománya jelentősnek számít. A magyar szuverén CDS-szpred és devizakötvény-hozamfelár hosszú távon együtt mozog, de a két ár különböző mikrostrukturális tényezők miatt rövid távon eltávolodhat egymástól. A magyar állam hitelkockázati felára alapvetően a magyar szuverén CDS-piacon határozódik meg, vagyis a magyar hitelkockázatra vonatkozó új információk először a CDS-szpredekbe épülnek be. A devizakötvény-piac ezzel szemben nem nevezhető hatékony piacnak, hiszen a devizakötvény-hozamfelárak csak követik a CDS-szpredek változását. Turbulens piaci periódusokban a magyar szuverén CDS-szpredek hajlamosak a fundamentálisan indokoltnál nagyobb mértékű emelkedésre.

1 Introduction

Credit derivative products, of which *credit default swap* (CDS) contracts are the most widespread, are considered the most successful financial innovation of recent years. Thanks to the global development of credit derivatives markets, by the middle of the 2000s a new market with steadily increasing liquidity emerged for the CDS contracts associated with the Hungarian foreign currency sovereign bonds. In order to carry out its responsibilities in an adequate professional manner, it is essential for the Magyar Nemzeti Bank to gather as much information as possible about this potential market of Hungarian credit risk pricing, even though public access to information about the operation of the Hungarian sovereign CDS market is highly restricted due to the peculiar nature of derivatives markets.

In this study we examine the position of the Hungarian sovereign CDS market in relation to the global credit derivatives markets, and the potential it offers to market participants investing in Hungarian instruments. We are primarily interested in the information contained in the available and observable CDS premia (also known as CDS spreads) on Hungary's credit risk and its developments, and in finding out how reliable that information is. Another important issue to look at is the role of the Hungarian sovereign CDS market in different market periods, and the long-term relationship it has with other domestic financial markets.

Several studies have been published in recent years on credit derivatives markets, particularly on certain CDS markets; the majority of these, however, have focused on CDS markets related to corporate bonds. Only a few papers have been devoted explicitly to the functioning and correlations of sovereign CDS markets, and we do not know of any studies analysing the CDS market data of our region in general or Hungary in particular. This study aims to fill this void.

The paper is structured as follows: Section 2 provides an overview of the characteristic features of CDS trading and the special characteristics of sovereign CDS contracts. Next we describe the functioning of the CDS market linked to Hungarian foreign currency sovereign bonds, followed by an estimate of the size of this market. The most important part of our study is Section 3, containing an empirical analysis of Hungarian sovereign CDS spreads. Following a presentation of the descriptive statistics of Hungarian sovereign CDS spreads, their information content is analysed in the subsequent sub-sections by the following methods: an analysis of the difference between CDS spreads and foreign currency bond yield spreads based on the no-arbitrage principle in the pricing of CDS spreads; a co-integration and error correction analysis widely used in the international literature in relation to the long-term relationship between the CDS market and the foreign exchange bond market and the primacy of price discovery; and the correlation between the credit rating of emerging countries and the level of the sovereign CDS spreads. Nearly all our findings are also evaluated in terms of international comparison. Finally, Section 4 provides a summary of our conclusions.

2 Sovereign CDS markets and the CDS market linked to the Hungarian sovereign foreign currency bonds

Considering their success and steady development, **credit derivative products** are by far the most prominent financial innovations of the last decade. A common feature of credit derivative products is that they are financial contracts to transfer the credit risks associated with – typically corporate or sovereign – bonds and loans from one party to another without transferring any other risks (such as exchange rate, interest rate, reinvestment risks, etc.) associated with these loans or bonds. The borrower or the issuer of the bond typically does not participate in the deal, which is made between two counterparties independently of the reference entity. The first derivative products emerged in the financial markets in the middle of the 1990s. While their popularity has steadily grown since then, in the middle of the 2000s their outstanding stock hit record highs. In 2006 the nominal amount outstanding of credit derivative contracts surpassed USD 20 trillion (Barret-Ewan, 2006), which represented a growth in excess of 300 per cent compared to 2004. Besides the high flexibility of these products, the liquidity-boosting effect derived from the standardisation of the documents associated with the deals also contributed to this dynamic growth, which has not shown signs of deceleration since 2006. Based on the semi-annual derivatives market survey conducted by BIS, and on data provided by BIS (2007) and ISDA (2008), at the end of 2007 the total nominal amount of outstanding credit derivatives may have exceeded USD 60-70 trillion.

Credit default swap (CDS) contracts constitute the basis for credit derivative markets. The first credit derivative products to gain popularity were CDS; even in 2006 their market share surpassed that of any other credit derivative products.[1] According to the semi-annual BIS survey we referred to above and to the data provided by ISDA (2008), at the end of 2007 the total nominal amount outstanding of traditional (linked to a single issuer or *single-name)* CDS contracts reached USD 30 trillion[2]. Credit default swaps are contractual agreements made between two parties for a pre-determined term to transfer the credit risk of a third party (the entity that issued the bond or the borrower, hereinafter the reference entity) from one party to the other. The term CDS refers to this credit risk swap. However, when we look at the functioning of these contracts and the pattern of the related cash flow, we find that CDS transactions are in fact much closer to insurance or option deals in content than to traditional *swap* transactions.[3]

According to market terminology, the buyer of the CDS buys protection, and the seller of the CDS is obligated to compensate the protection buyer by paying the nominal value of the bond or the loan if the reference entity defaults. The protection buyer makes a series of periodic payments to the protection seller and profits from the contract only if the reference entity defaults or the market's collective judgement of the credit rating of the reference entity deteriorates during the term of the CDS. Thus the CDS buyer effectively takes on a short position in the credit risk, similarly to short selling a bond. The protection seller, in contrast, receives periodic payments, and makes a profit on the deal if the credit rating of the reference entity remains stable or improves up until the maturity of the CDS. Thus the CDS seller essentially assumes a position in credit risk similar to holding a bond. Obviously, the CDS buyers or sellers do not need to lock their positions until maturity; by entering into an offsetting contract they might choose to close the deal with a profit or a loss, depending on the size of the prevailing fees.

The regularly paid premium is commonly known as a **CDS spread** in international terminology. The term spread usually refers to a type of interest rate margin or interest rate premium. On the one hand, the premium paid regularly under CDS contracts is called a spread because its amount is determined in basis points. The regularly paid premium is the product of this amount defined in basis points and the total nominal value of the underlying bonds or loans of the CDS contract between the parties. On the other hand, we may look at the regularly paid premium as a portion of the regular interest income paid by the reference entity to the party holding the bond or loan instrument, which the latter passes on to the protection seller

[1] Based on the survey of the *British Bankers' Association,* see Barret–Ewan (2006).

[2] In addition to CDS contracts, recent years have seen substantial growth in turnover for CDS index trades *(multi-name* CDS) and other structured credit derivative applications such as *synthetic collateralised debt obligation* (synthetic CDO) contracts, tranched index trades and securities linked to credit risk *(credit linked notes).* These products are not directly related to the subject of this study; for more details see JPMorgan (2006).

[3] See Csávás–Varga–Balogh (2007) for details on the characteristic features and classification of traditional *swap* transactions.

in exchange for the seller's assumption of the credit risk associated with the reference entity. Thus, in this sense, the regularly paid premium is a portion of the received interest payable in exchange for taking on credit exposure (credit risk premium).

There are two major groups of **driving forces** behind the participation in CDS contracts (and essentially in any other credit derivative transaction). First, credit risk associated with holding loan or bond portfolios can be reduced or even completely eliminated by means of CDS deals. Second, the application of credit derivatives allows the investor to take and switch positions easily and flexibly, betting on positive or negative future changes in the creditworthiness of an economic player. Achieving this latter goal does not even require the investor taking on a position in the credit derivative market to have exposure to the specific economic player. Speculating on changes in an entity's creditworthiness and taking up positions accordingly substantially contributed to the surge of credit derivatives in recent years, as credit derivatives allow investors to take such positions with an ease and flexibility that would not be possible by means of the underlying loan or bond instruments alone.

Based on the sector of reference entities, global CDS markets can be divided into two major groups: CDS markets linked to corporate (including bank-issued) bonds and sovereign bonds. CDS deals with underlying corporate bonds are by far the more predominant of the two. While quotes related to sovereign bonds still constituted more than half of global CDS market quotes in 1997, this ratio plummeted to 7 per cent by 2003 (Packer and Suthiphongchai, 2003). Even though recent years have seen a considerable turnover growth in sovereign CDS deals – as has been the case in the global market overall – data provided by the large credit derivative brokers interviewed by us suggest that their market share did in fact continue to decrease and dropped to 5-6 per cent. Based on this data, the nominal outstanding amount of sovereign CDS deals must have been around USD 1.5-1.8 trillion at the end of 2007, which is consistent with the data reported by BIS (2007). In the early 2000s CDS contracts with the underlying foreign currency bonds of emerging countries accounted for the vast majority of sovereign CDS turnover, representing over 90 per cent (Packer-Suthiphongchai, 2003). The information we obtained from market participants and credit derivative brokers suggests that this ratio has not changed significantly since then. According to the study we referred to above, Poland – with a market share of 4 per cent – is the only sovereign CDS market in the region which is counted among the first 15 countries with the largest volume of quotes. The market is highly concentrated: of the 77 countries listed, 80 per cent of all quotes were related to the leading 15 countries.

Most features of sovereign CDS deals are identical to those of corporate CDS deals, except of course that it is a country's credit risk which is transferred between the market participants under a sovereign CDS contract. A sovereign CDS contract may be of any maturity. However, the most favourable terms are between 1 and 10 years, of which a 5-year-term tends to be the most liquid, according to market participants. In the case of a default event on the part of the specific sovereign reference entity (typically a failure to pay, debt restructuring or moratorium), the protection buyer delivers to the protection seller any bond under the terms of the contract issued by the reference entity in the face value equal to the nominal value specified in the CDS, in return for which the protection seller pays the buyer the par value of the bond. Rather than physically delivering the bonds affected by the default event, it has also become increasingly popular in the sovereign CDS markets to use a cash settlement for the conclusion of CDS contracts. In this case the protection buyer does not have to deliver the bonds; instead the protection seller pays the buyer the difference between the par value and the post-default market value of the affected bonds. Under the terms of sovereign CDS contracts, in the case of a default event government bonds issued by the specific sovereign can be generally delivered denominated in any accepted foreign currency listed in the ISDA Master Agreement (euro, US dollar, pound sterling, Japanese yen, Swiss franc, Canadian dollar). In sovereign CDS trades, the CDS spread is also quoted as an annual premium payable by the protection buyer. However, as is the case in other CDS markets, it is typically paid in quarterly instalments, and the nominal amount of the payment is the specific par value multiplied by the specific portion of the CDS spread computed for the length of the given quarter (length of the quarter in days/360).

Under Hungarian sovereign CDS contracts, the counterparties can transfer the credit risks of foreign currency bonds issued by the Hungarian government. Reliable information regarding the Hungarian sovereign CDS market is scarce. Similar to other credit derivatives markets, the Hungarian sovereign CDS market is a typical OTC (over-the-counter, unregulated) market where the scope of market participants and their trading motives are hard to grasp. There are no real dealers; trading takes place through credit derivative brokers, who pair up the anonymous but nevertheless binding bids of market participants, typically submitted by electronic mail. The majority of credit derivative brokers are based in London or New York. According to the triennial BIS survey on global foreign exchange and derivatives market activity (BIS [2007]) and information provided by domestic credit institutions, Hungarian market participants do not enter into Hungarian sovereign CDS contracts. Active

participants in the market include global investment banks, hedge funds and other non-resident fund managers, typically motivated by the possibility of taking flexible positions, which allows them to take advantage of the changes in the credit risk premium of the Hungarian government. Trading is based on the terms of the ISDA Master Agreement, which has been widely used in credit derivatives markets; price quotes typically refer to nominal values of EUR 5-10 million. In line with global trends, contracts with 5-year maturity are the most liquid in the Hungarian sovereign CDS market. According to the information provided by credit derivative brokers, the Hungarian sovereign CDS market achieved an adequate level of liquidity around the end of 2005 and early 2006, which marked the beginning of a gradual turnover growth; liquidity growth peaked in the first half of 2008.

Data collected from the largest global credit derivative brokers indicate that the liquidity of the Hungarian sovereign CDS market is low relative to the average liquidity of credit derivatives markets, the number of quotes placing it in the lowest quarter of sovereign CDS markets. Nevertheless, **brokers receive 30-40 binding quotes on a daily basis from an average of ten banks, accounting for 1-3 per cent of all sovereign CDS quotes.** In 2002, 6 per cent of all binding price quotes led to actual trades (Packer-Suthiphongchai, 2003). Assuming that this ratio has not changed substantially, based on the number of binding quotes we find that on average two Hungarian CDS contracts are made on a daily basis. On the other hand, in view of the dynamic acceleration of turnover in the past two years we may reasonably assume that the number of actual trades in proportion to price quotes should have increased as well; hence our estimate of two transactions per day is rather conservative. Considering the typical price quotes of EUR 5-10 million, **the daily turnover of the Hungarian sovereign CDS market should amount to at least EUR 10-20 million.** While these values significantly lag behind the turnover of the most liquid CDS markets, the Hungarian sovereign CDS market is much more liquid than the secondary market of the underlying Hungarian sovereign foreign currency bonds, where no daily trades are performed, according to information from market participants.

Based on the data provided by credit derivative brokers, we can also estimate the outstanding stock of Hungarian sovereign CDS contracts. According to the semi-annual derivatives market survey conducted by BIS, the total nominal amount outstanding of global CDS contracts increased by USD 22 trillion between the end of 2005 and the end of 2007, of which roughly 5 per cent – as mentioned above – is definitely generated by sovereign CDS markets, amounting to around USD 1.1 trillion. If we agree that the Hungarian sovereign CDS market achieved an adequate liquidity level at the end of 2005 and the Hungarian sovereign CDS turnover has accounted for 1-3 per cent of the total sovereign CDS turnover since, then **the total amount outstanding of Hungarian sovereign CDS contracts must have accounted for USD 10-30 billion (EUR 7-20 billion) of the USD 1.1 trillion growth of the outstanding stock of global sovereign CDS at the end of 2007.** Comparing this value to USD 21 billion – the total amount outstanding of foreign currency bonds issued by the Hungarian government as of the end of 2007 – it is evident that despite its daily turnover lagging far behind the average turnover of the more liquid credit derivatives markets, the Hungarian sovereign CDS market can still be considered a significant market from a Hungarian perspective.

3 The information content of Hungarian sovereign CDS spreads

3.1 DATA

In this section we apply different empirical methods to analyse the information content of the CDS spreads related to Hungarian sovereign foreign currency bonds, and the Hungarian sovereign CDS market's relationship with the Hungarian sovereign foreign currency bond market and the forint-denominated government securities market. The CDS spreads applied in the analyses derive from Datastream and Bloomberg, whose original source is CMA, one of the leading market platforms providing trading data of credit derivative products. The source for foreign currency bond yields is Bloomberg. Hungarian data were available for the period between 6 February 2004 and 18 June 2008. In most cases the Hungarian results are also presented in international comparison. In addition to Hungary, in the international analyses we applied data from the following 14 emerging countries (where available), which are relevant from the perspective of the relative development of the Hungarian economy and Hungarian financial markets: Brazil, Bulgaria, the Czech Republic, the Republic of South Africa, Estonia, Croatia, Poland, Latvia, Lithuania, Russia, Romania, Slovakia, Turkey and Ukraine. For the most part, based on the availability of data, in our international analyses we focused on the period between 3 January 2005 and 30 May 2008.

3.2 THE NO-ARBITRAGE PRINCIPLE OF CDS SPREADS

CDS spreads linked to Hungarian sovereign foreign currency bonds reflect the price of Hungary's credit risk. Obviously, the same price should also be incorporated into the yield of foreign currency bonds issued by the Hungarian government; this portion of the yield is called the credit risk premium. On the whole, if the same price is determined in two different financial markets, there will be a potential for arbitrage between the two markets. Based on the extent to which this potential for arbitrage is reflected in the pricing dynamics of the two markets, we can draw conclusions regarding the tightness of the relationship between the two markets, and we can gauge which market pricing provides more reliable information, in our case on the credit risk premium associated with a certain country. Since in Hungary we can observe both the credit risk premium of sovereign foreign currency bonds and the related CDS spreads, it may provide valuable information for us to see whether there is any difference between the information content of the two prices determined with respect to the Hungarian sovereign credit risk.

As several studies have shown, including those by Duffie (1999), Blanco at al. (2003), Hull et al. (2004) and Ammer and Cai (2007), there is a perfect arbitrage opportunity between a risky bond with a floating interest rate traded at par value, a risk-free par bond of corresponding maturity also with a floating interest rate, and a CDS contract of corresponding maturity. For perfect arbitrage the risk-free bond should be traded at par across its entire maturity, and each parameter of the two bonds should be identical with each other (including the liquidity of their secondary market). If an investor buys such a risky bond with an annual yield to maturity of y and buys credit protection on it for the same maturity in the CDS market, then his position will be the same as if he had bought a risk-free bond with the same parameters.[4] Consequently, if the annual cost of the credit protection expressed as a percentage of the nominal value is p_{CDS}, and the annual yield of the risk-free bond is y_{RF}, then the following formula should also be true:

$$y_{RF} = y - p_{CDS} \tag{1}$$

For $y_{RF} < y - p_{CDS}$, the investor would make a risk-free profit by buying a risky bond, buying protection, and shorting the risk-free bond; for $y_{RF} > y - p_{CDS}$, buying a risk-free bond, shorting the risky bond and writing protection would be profitable. If the linkage between the markets is not hindered by transaction costs, the above arbitrage opportunity ensures that formula (1) is always true. The same relationship could be expressed in a different form by means of the definition of the CDS-bond

[4] It should be noted that even this theoretical arbitrage opportunity cannot be considered perfect unless we disregard the partner risks associated with CDS deals, i.e. that for whatever reason, the protection seller is unable to pay the protection buyer the risky bond's nominal value in the case of a default event.

basis. The CDS-bond basis (p_{BS}) is the difference between the CDS spread and the yield spread of a risky bond of corresponding maturity over a risk-free bond. Based on formula (1), assuming a perfect arbitrage opportunity between the two markets, the basis is always equal to zero, that is:

$$p_{BS} = p_{CDS} - (y - y_{RF}) = 0. \quad (2)$$

Nevertheless, when analysing the relationship between the two markets, we should remember that there is no perfect arbitrage opportunity; for various reasons, in reality these opportunities are always subject to imperfections. On the one hand, floating-rate bonds are rare; consequently, bond prices in secondary market trading usually depart from the nominal value to some degree. Furthermore, in practice it hardly ever happens that a fixed rate bond is traded at par across its entire maturity (which would assume a constant and completely flat yield curve during the entire term). Nevertheless, the referenced empirical studies found that the credit risk premium computed from fixed rate bonds trading close to par was generally a reliable measure of the theoretically accurate value; hence any distortion that may have occurred should be negligible.

Another factor to consider is the fact that investors, particularly in the case of the sovereign foreign currency bonds of emerging countries, do not have an opportunity to short-sell risky bonds, as in most cases – apart from the most sophisticated markets – there are no related liquid security lending or repo markets. However, for the sovereign foreign currency bonds of emerging markets, the government bonds of the most developed countries denominated in their own currencies are a good approximation of risk-free bonds, and it is usually easier to short-sell those bonds in their secondary markets. This might render the relationship between the markets asymmetric. If the CDS-bond basis is negative, i.e. the credit risk premium on the risky bond is higher than the theoretically true value (or the CDS spread is too low), the arbitrage is easier to complete (as it requires the short selling of the risk-free bond), thus the negative basis can adjust back to zero faster. On the other hand, if the basis is positive (i.e. the credit risk premium is too low or the CDS spread is too high), the investor might run into difficulties completing the arbitrage (as this would require the short selling of the risky bond), thus the positive basis could remain in the positive zone more persistently.

Moreover, we should recognise that there is usually a significant difference between the liquidity of the sovereign foreign currency bond markets of emerging countries and the government bond markets of the most developed countries. The financial markets of emerging countries are typically much less liquid, hence the yield spread of their foreign currency bonds contains a liquidity premium in addition to the credit risk premium. This might facilitate the evolution of a negative CDS-bond basis.

Ammer and Cai (2007) argue that following a default event, the post-default value will not necessarily be the same for all bonds issued by the reference entity affected by the default; moreover, current market expectations may also assume that the post-default values would vary. Since in the sovereign CDS markets any bond issued by the reference entity that is denominated in an eligible currency can be usually delivered following a default event, the differences in post-default value, as well as the expectations regarding those values, provide an option to the protection buyer to deliver the least valuable post-default instrument (cheapest-to-deliver or CTD option). If the expectations regarding the formation of different post-default prices were well-founded, this is a profitable option for the protection buyer, which must be reflected in the CDS spread paid in return for the protection, which could put an upward pressure on the CDS basis. Based on the number and characteristics of Hungarian sovereign foreign currency bonds, any possible distortion of the Hungarian CDS-bond basis triggered by a potential CTD option should be negligible. On the whole, we find that among the potential distorting factors of arbitrage opportunities, there are some that may lead to a positive basis and some that may lead to a negative basis.

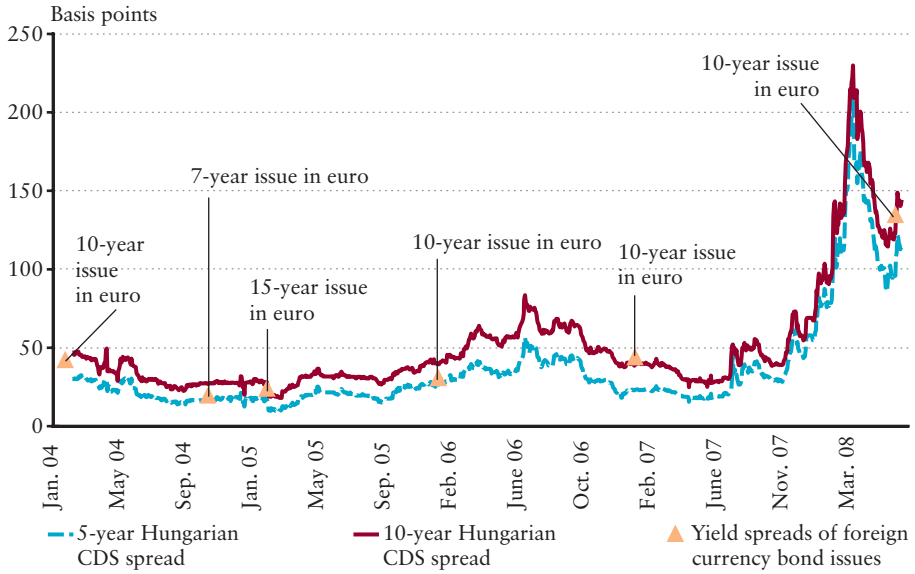
Beyond the factors described above as inhibiting the formation of a theoretically perfect arbitrage opportunity in the CDS market specifically, the existence of market transaction costs – as is the case in all other financial markets – also works against a perfect match between the two prices, i.e. a CDS-bond basis staying at zero for any notable duration is unrealistic. From this perspective, the two most important transaction costs are the bid-ask spread (the difference between buying and selling rates) and the administrative, technical and human resource expenses required for market access. Due to these two cost types, arbitrage mechanisms will commence only if the difference between the two prices reaches a critical level. The value of this critical level may vary depending on the level of market sophistication, and the CDS-bond basis can freely fluctuate as long as it remains below the critical level.

3.3 DESCRIPTIVE STATISTICS OF THE HUNGARIAN SOVEREIGN CDS SPREADS

The easiest and most obvious way to compare the yield spread of foreign currency bonds issued by the Hungarian government and the level of Hungarian sovereign CDS spreads is to use the date of issue of the sovereign foreign currency bonds as a reference date. While the values of sovereign CDS spreads are available on a daily basis, determining the comparable credit risk premia on foreign currency bonds is a more challenging task. The use of sovereign foreign currency bond yields as of the date of issue is a good starting point, because they denote the market price of a complete bond series in typically high denomination, i.e. it is highly reliable. Moreover, the initial maturity of foreign currency bonds is typically a round number, such as 10 years, which is easy to match with the maturity of CDS spreads, always a round number as well.

Chart 1

Initial yield spread of the Hungarian sovereign foreign currency bonds and the Hungarian CDS spreads



Source: Government Debt Management Agency, Bloomberg, own calculations.

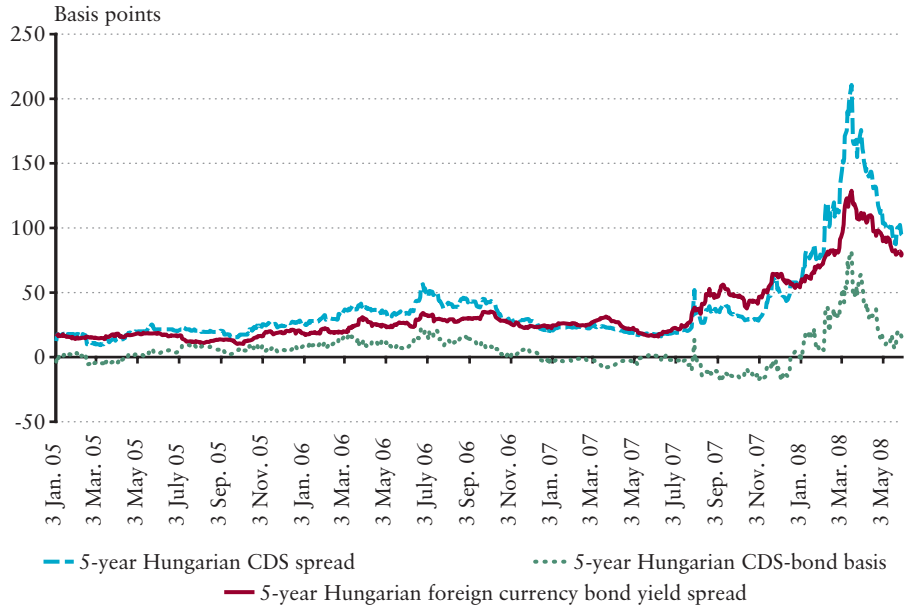
In order to determine the credit spread on foreign currency bonds, we compared the initial foreign currency bond yields with their comparable benchmark across the specific maturity, i.e. the secondary market yield of euro-denominated German government bonds. On the whole, until the beginning of 2006 corresponding maturity CDS spreads typically surpassed the initial yield spread of sovereign foreign currency bonds (Chart 1). The yield spreads of 10-year, euro-denominated foreign currency bonds issued in 2007–2008, however, were practically identical with the value of the 10-year CDS spread on the same day. These figures might suggest that in 2007 the two markets started to price Hungary's credit risk equally, nevertheless, we should not rush to conclusions based on the two cases available; moreover, we cannot even determine the cause and effect relationship between the pricing differences of these two markets. A more in-depth examination of the information content of Hungarian sovereign CDS spreads can be achieved by means of time series analysis with a higher, preferably daily, frequency.

We will examine the long-term relationship on a daily basis between the Hungarian sovereign foreign currency bond market and the CDS market by means of an empirical analysis of the 5-year Hungarian CDS-bond basis in the period between 3 January 2005 and 30 May 2008. The reason for selecting a 5-year maturity is the general opinion – confirmed by market participants – that it is the most liquid maturity in the sovereign CDS market (as is the case for CDS markets in general). The time series of 5-year Hungarian CDS spreads is available for the calculation. As the daily CDS spread quotes refer to the price of a CDS contract with a maturity of exactly five years, we need to establish the exact 5-year maturity Hungarian sovereign

foreign currency bond yield spreads for each day of the sample period.[5] Due to the limited number of Hungarian sovereign foreign currency bonds, we cannot develop a yield curve, thus we generated the exact 5-year yield to maturity by means of an interpolation procedure similar to what is used by Blanco et al. (2003), ECB (2004) and (2007) and In et al. (2007). We selected two fixed interest, euro-denominated, high face value Hungarian sovereign foreign currency bonds which trade close to par. One of the bonds had less, while the other had more than five years to maturity during the entire sample period. By linearly interpolating their yields, we computed the exact five-year yields of a Hungarian sovereign foreign currency bond for each day of the sample period. From these yields, we then deducted the current value of the 5-year, euro-denominated German benchmark government yield each day, which should be default-free from a credit risk perspective. Due to the imperfections of linear interpolation, our estimated value of the credit spread of Hungarian sovereign foreign currency bonds, and thus our estimation of the CDS-bond basis is somewhat distorted. However, this distortion is insignificant.[6]

Chart 2

Time series of five-year Hungarian CDS-bond basis



Source: Government Debt Management Agency, Bloomberg, own calculations.

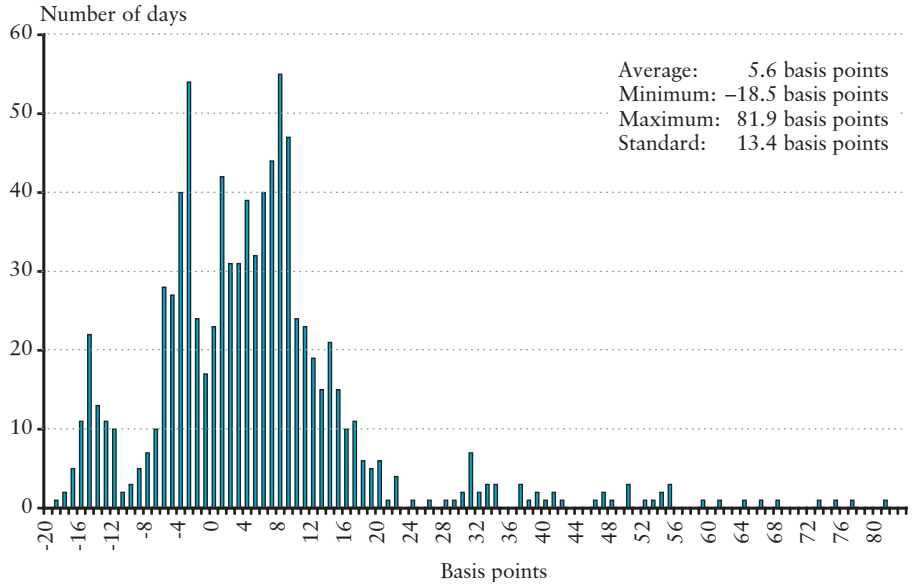
The 5-year Hungarian CDS spread closely followed the 5-year Hungarian foreign currency bond yield spread in the sample period. Accordingly, the CDS-bond basis fluctuated close to zero for most of the sample period (Chart 2). This result suggests that there is a close relationship between the secondary market of Hungarian sovereign foreign currency bonds, and the CDS market related to Hungarian sovereign foreign currency bonds. The only notable difference was observed during the few weeks between the beginning of March and the middle of April 2008, when the CDS spread exhibited a significant widening, departing from the foreign currency bond yield spread by over 50 basis points. As this pattern appeared to be rather exceptional in the relationship between the CDS spread and the foreign currency bond yield spread, we will elaborate on the possible reasons for the widening later. For the rest of this section, however, our primary focus is analysing the long-term relationship between the two credit spreads.

[5] Strictly speaking, even the euro-denominated German government bonds are not default-free, hence, the prudent choice would theoretically be if we did not simply compare the 5-year Hungarian sovereign CDS spread to the 5-year foreign currency bond yield spread, but to the difference between the 5-year Hungarian sovereign foreign currency bond yield and the 5-year euro-denominated German government bond yield minus the 5-year German CDS spread. By using the simple foreign currency bond yield spread, we theoretically underestimate the price of Hungary's credit risk. However, considering that the 5-year CDS spread on German government bonds amounted to only a few basis points in the sample period, the magnitude of the distortion is negligible. Moreover, this slight underestimation of the price of Hungary's credit risk is also offset by the fact that other than credit risk, the characteristic features of Hungarian foreign currency bonds (e.g. a higher liquidity premium than German government bonds) put an upward pressure on the estimated price of Hungary's credit risk approximated by the foreign currency bond yield spread.

[6] In order to assess the magnitude of distortion, we also generated by linear interpolation the exactly five-year yields of euro-denominated German government bonds for each day of the sample period, which we then compared to the current values of the 5-year German benchmark yield. We found that the two yields moved close to one another; the average absolute basis of the daily differences was 2 basis points across the full sample period.

Chart 3

Distribution of the five-year Hungarian CDS-bond basis
(January 2005–May 2008)



Source: Government Debt Management Agency, Bloomberg, own calculations.

Chart 3 also confirms that the Hungarian sovereign foreign currency bond market and the CDS market were in a close relationship during the sample period. Between 3 January 2005 and 30 May 2008 the average Hungarian CDS-bond basis was 5.6 basis points, with 13.4 basis points standard deviation. The distribution of the basis is considerably skewed to the right, resulting from the period March-April 2008 as described above. In view of the already discussed imperfections distorting any theoretical arbitrage opportunity between the two markets, we cannot even expect the basis to be precisely zero. Taking into account the inaccuracy of our estimate regarding the credit spread of Hungarian sovereign foreign currency bonds, as well as the value of the bid-ask spreads customary in these markets, if the basis fluctuates in the range of ±10-15 basis points, it is an indication that the two markets are in a fundamentally close relationship. During our sample period, for 67 per cent of the trading days the CDS-bond basis was in the range of ±10 basis points, while it stayed in the range of ±15 basis points for 85 per cent of the trading days.

We have also examined the descriptive statistics of the 5-year Hungarian CDS-bond basis in international comparison. Due to a lack of information on the yield spreads of the relevant foreign currency bonds, for 4 of the original 15 reference countries (Bulgaria, the Czech Republic, Estonia and Russia) we were unable to estimate the daily time series of the CDS-bond basis; while for Latvia and Lithuania the availability of reliable data was limited to the period between August 2007 and May 2008. For the reference countries, we estimated the credit spread on foreign currency bonds similar to the calculations applied to Hungarian data. First, by applying linear interpolation we calculated the exact five-year yield for each day of the sample period from the yields on fixed interest, different-maturity, foreign currency par bonds, from which we then deducted the corresponding 5-year euro-denominated and USD-denominated benchmark government bond yields. Based on the number and liquidity of each country's foreign currency bonds denominated in different currencies and based on CDS market standards, we used USD-denominated bonds for Brazil, the Republic of South Africa and Ukraine, and euro-denominated bonds for the rest of the countries for the calculation of the yield spread.

In most emerging countries the average CDS-bond basis was negative in the sample period, as opposed to the positive figure measured in Hungary (Table 1). However, the minimum and maximum values indicate that between January 2005 and May 2008 most countries saw both negative and positive values, except the Republic of South Africa where the basis was exclusively negative, and Turkey, where the basis was exclusively positive throughout the entire sample period. The best way to measure the difference between the CDS spread and foreign currency bond yield spread of specific countries is to compare average absolute bases, which eliminates the distortions caused by alternating positive and negative bases. With 9.7 basis

Table 1

Descriptive statistics of the five-year CDS-bond basis of emerging countries

(January 2005–May 2008)

	Average basis	Minimum	Maximum	Standard deviation	Average absolute basis
Hungary	5.6	-18.5	82.0	13.4	9.7
Brazil	14.7	-95.6	84.8	40.6	37.3
Republic of South Africa	-42.6	-110.2	-6.6	16.2	42.6
Croatia	-12.3	-43.9	21.9	11.2	13.1
Poland	-8.3	-34.1	15.8	7.9	8.7
Latvia*	-2.7	-72.7	72.2	27.7	21.8
Lithuania*	-35.6	-82.2	7.7	20.6	35.9
Romania	-9.9	-40.4	74.3	14.1	14.7
Slovakia	-8.9	-28.1	8.1	6.4	9.0
Turkey	56.8	2.5	158.1	26.9	56.8
Ukraine	-2.7	-86.0	68.4	21.4	15.2

** Statistics for Latvia and Lithuania cover the period between August 2007 and May 2008.*

Source: Government Debt Management Agency, Bloomberg, own calculations.

points, the average absolute CDS-bond basis measured in Hungary can be considered low in international comparison; of all the countries in our sample only Poland and Slovakia produced a value under 10 basis points. Only a slight difference is observed between the pricing of the two markets in Croatia, Romania and Ukraine, where the average absolute basis is measured between 10 and 15 basis points. For the remaining countries the average absolute differences are more significant, exceeding 20 basis points.

3.4 LONG-TERM RELATIONSHIP BETWEEN THE HUNGARIAN SOVEREIGN FOREIGN CURRENCY BOND MARKET AND THE HUNGARIAN SOVEREIGN CDS MARKET

Besides the above descriptive statistics, there are more formal methods of examining the long-term relationship between the secondary market of Hungarian sovereign foreign currency bonds and the CDS market linked to Hungarian sovereign foreign currency bonds. Since foreign currency bond spreads and CDS spreads usually appear to follow a unit root process, their relationship cannot be analysed with traditional regression tools based on the method of ordinary least squares. Accordingly, similarly to Blanco et al. (2003), ECB (2004) and (2007), Wit (2006), Ammer and Cai (2007) and In et al. (2007) we apply a cointegration method to examine how close the connection between these two markets is.

Assuming that the foreign currency bond spreads and CDS spreads follow a unit root process, and that the credit risk pricing of these two markets are not independent of each other in the long run, it is reasonable to conclude that the CDS spreads and the credit spreads of corresponding maturity foreign currency bonds cointegrate. Formally this means that if $p_{CDS,i}$ denotes the corresponding maturity CDS spread of state *i,* and $p_{CS,i}$ denotes the credit spread on the same maturity foreign currency bond of state *i,* then

$$P_{CDS,i} = \alpha + \beta p_{CS,i} + \varepsilon_i, \tag{3}$$

where ε_i is stationary. However, the level of correspondence between a country's foreign currency bond market and CDS market can vary; and by means of the cointegration parameters we can estimate that level.

If the two markets price the credit risk of the specific country equally, the CDS spread and the corresponding maturity foreign currency bond credit spread will cointegrate in the long run, and any short-term deviation of the prices can only be caused by microstructural noise. Formally, this means that in cointegration equation (3), parameter β will be 1, thus the cointegration vector will be [1, –1] and α will be zero. This suggests a very close relationship, encouraging the above mentioned perfect arbitrage opportunities between the two markets. Nevertheless, it is more of a theoretical possibility, as the average difference

between sovereign CDS spreads and foreign currency bond credit spreads is typically not zero over the long run, as we noted under Table 1. As demonstrated above, this is in part due to estimation errors, the existence of transaction costs, the segmented nature of the two markets and their different liquidity, and factors inhibiting the realisation of theoretical arbitrage opportunities.

As a result, if α is not zero and β is 1 in the cointegration equation, we still cannot reject the notion that the foreign currency bond market and CDS market of the specific country price the credit risk equally. In this case we can also conclude that the two markets price the changes of credit risk equally; however, foreign currency bond spreads and CDS spreads may still permanently deviate from each other. The two markets are probably not separated significantly, and they should not differ much in terms of liquidity. Consequently, we can conclude that the two markets are closely related in this case as well. If CDS spreads and foreign currency bond spreads cointegrate, but the cointegrating vector is not [1, -1], the two prices will still move in tandem in the long run, while in the short run the two markets may price credit risk differently to various degrees. Consequently, we again find support for a relationship between the two markets; however, its level is lower than it was in the previous cases. This scenario might indicate that the two markets have different liquidity, the number of participants active in both markets is low, or that the existence of significant transaction costs prevents market arbitrage forces from coming into effect. Finally, if CDS spreads and foreign currency bond spreads do not cointegrate, that signals a complete separation between the two markets. A lack of connection between the markets may lead to a drastically different pricing of credit risk, and the two prices can in fact move in unrelated ways.

As is the case with our previous calculations, the cointegration analysis was performed by using the most liquid, 5-year CDS spreads and the related 5-year foreign currency bond yield spreads. For more accurate interpretation and international comparability, the analysis was extended to the CDS spreads and foreign currency bond yield spreads of additional emerging markets. The analysis was first performed for the period between 3 January 2005 and 30 May 2008, the longest period with daily data available. This involved 890 observations per country and per market.

Both the information provided by market participants and our results pertaining to the liquidity of the Hungarian market as described in Section 2 suggest that the turnover of the Hungarian and other sovereign CDS markets started to pick up from 2006, and the beginning of 2008 saw a spectacular surge in turnover, even surpassing previous significant growth. Thus there is a risk that data obtained on the insufficiently liquid markets of 2005 may distort our findings; moreover, previously valid correlations may have changed during 2008. In view of these considerations, in addition to the original long-term period, analysis was performed for the period between 2 January 2006 and 30 May 2008 (630 observations), as well as for the period between 2 January 2008 and 30 May 2008 (108 observations). While the analysis for 2008 relies on considerably less observations than the previous analyses, we were able to extend it to Latvia and Lithuania, as reliable information became available for the period. Comparison of these three periods may also be interpreted as a robustness analysis. As the five-year CDS spread and the estimated foreign currency bond yield spread followed a unit root process in every selected country in the sample periods, we were able to perform the cointegration analysis.

Based on the results of the Johansen cointegration analysis, there is evidence of cointegration between the five-year Hungarian sovereign CDS spread and the five-year Hungarian sovereign foreign currency bond yield spread in all three sample periods (at the 5% significance level, we reject the null hypothesis suggesting the opposite, as shown in Table 2). On the other hand, based on the test statistics shown in the second column of the specific periods, for each sample period we also reject the null hypothesis of value [1, -1] for the cointegrating vector. As noted above, our results indicate that the **Hungarian sovereign CDS spread and foreign currency bond yield spread cointegrate in the long run. However, the two prices may deviate from one another in the short term due to transaction costs, differing market liquidity and additional microstructural factors.** According to our estimate, the value of the cointegration parameter β exceeded 1 across all sample periods; its value increased as time progressed, and moved between 1.63 and 1.97. This implies that **between the two prices of Hungarian sovereign credit risk, the CDS spread proved to be the more volatile in the past; over the long run a 1 basis point change in the foreign currency bond yield spread was accompanied by a 1.6-2 basis points change of the CDS spread.** In line with the turnover data indicated in Section 2, this implies that the liquidity of the Hungarian sovereign CDS market is greater than that of the Hungarian sovereign foreign currency bond market. On the whole, our results concerning the long-term relationship between the Hungarian sovereign foreign currency bond market and the CDS market are sufficiently robust; similar conclusions could be drawn from the estimates across all sample periods.

Table 2

Long-term relationship between the sovereign foreign currency bond market and CDS market of emerging countries

	Null hypotheses					
	2005–2008		2006–2008		2008	
	No cointegration	$\beta=1$ (estimated β)	No cointegration	$\beta=1$ (estimated β)	No cointegration	$\beta=1$ (estimated β)
Hungary	21.63*	9.08* (1.63)	23.56*	14.30* (1.82)	21.41*	12.74* (1.97)
Brazil	32.16*	6.05* (0.88)	28.52*	3.68+ (0.79)	17.13*	1.02
Republic of South Africa	22.15*	0.58	15.34		9.20	
Croatia	20.72*	1.28	18.11+	1.35	24.27*	3.82+ (1.31)
Latvia					15.77*	1.13
Lithuania					16.82*	5.79* (1.60)
Poland	21.73*	2.10	18.02+	3.37+ (1.44)	16.97*	3.77+ (1.63)
Romania	24.49*	16.48* (1.36)	15.72*	11.05* (1.37)	29.61*	14.95* (3.25)
Slovakia	20.31*	0.62	16.73+	1.65	15.60*	6.25* (1.76)
Turkey	19.70*	4.39* (1.52)	29.33*	0.01	18.16*	5.96* (2.53)
Ukraine	53.13*	27.60* (0.76)	33.95*	25.52* (0.71)	19.17*	8.04* (0.39)

The first columns of the specific periods present Johansen trace test statistics for the five-year CDS spreads and five-year foreign currency bond yield spreads of the sample countries. The number of lags in the underlying vector autoregression is defined by the Akaike Information Criterion (AIC). The second columns display test statistics for restrictions on parameter β of the cointegration equation for those countries where a cointegrating relationship appears to be present. Following the test statistics of the second columns, we present in parentheses the estimated value of parameter β for those cases where the restriction of β=1 was rejected.

*Next to the values in the table, * and + signs show the rejection of the null hypotheses indicated in the header of the table at 5 and 10 per cent significance level respectively.*

Similar to Hungary, the foreign currency bond yield spread and the CDS spread cointegrated in all sample periods for nearly all emerging countries listed in Table 2. The Republic of South Africa was an exception; here we found a cointegrating relationship in the longest sample period only, for 2005–2008. Moreover, during the period of 2006–2008 the cointegrating relationship became less tight in the cases of Croatia, Poland and Slovakia (we could only reject the no-cointegration null hypothesis at 10 per cent significance level). We did not find any country where the value of the cointegrating vector was [1, -1] in all three sample periods. For two countries, Croatia and Slovakia, our cointegration analysis found that parameter β of the cointegrating relationship took the value of 1 in the periods beginning in 2005 and 2006. In 2008, however, when the liquidity of the sovereign CDS markets of emerging countries significantly improved, only two countries remained of the ten (with evidence of a cointegrating relationship) where we could not reject the null hypothesis of a [1, -1] cointegrating vector – Brazil and Latvia. Similar to Hungary, the estimated values of β exceeded 1 for most countries, and we even found values of over 2 and 3 in 2008. There were only two countries, Brazil and Ukraine, where the value of parameter β was less than 1 throughout more than one period. We may conclude that **similar to Hungary, the sovereign foreign currency bond spread and CDS spread of the majority of emerging countries move in tandem in the long run even though they may temporarily deviate from one another, and that the CDS spread proves to be the more volatile of the two credit risk spreads.**

3.5 PRIMARY MARKET OF THE PRICE DISCOVERY OF HUNGARY'S CREDIT RISK

As the findings of the previous Section suggest, while the Hungarian sovereign CDS spread and the foreign currency bond yield spread may temporarily deviate from one another, they do cointegrate in the long run. Therefore, the question arises as to which of the two markets contributes most to the credit risk price discovery process, and which of them merely adjusts to the pricing of the primary market. This information is particularly important for the evaluation of the information content of the Hungarian sovereign CDS spreads, since the primary market of price discovery provides the most up-to-date information about the level of the Hungarian sovereign credit spread as well as its changes. Since the CDS spreads and foreign currency bond yield spreads subject to our analysis are cointegrated, we will analyse the two markets' role in the price discovery process

with the error correction method introduced by Gonzalo and Granger (1995), also applied by Blanco et al. (2003), ECB (2004) and (2007) and In et al. (2007). According to the preferred method, in order to determine the contribution of each market to price discovery, the first step is to estimate the following vector error correction model:

$$\Delta p_{CDS,t} = \lambda_1\left(p_{CDS,t-1} - \alpha - \beta\, p_{CS,t-1}\right) + \sum_{j=1}^{p}\gamma_{1j}\Delta p_{CDS,t-j} + \sum_{j=1}^{p}\delta_{1j}\Delta p_{CS,t-j} + \varepsilon_{1t} \quad (4a)$$

$$\Delta p_{CS,t} = \lambda_2\left(p_{CDS,t-1} - \alpha - \beta\, p_{CS,t-1}\right) + \sum_{j=1}^{p}\gamma_{2j}\Delta p_{CDS,t-j} + \sum_{j=1}^{p}\delta_{2j}\Delta p_{CS,t-j} + \varepsilon_{2t} \quad (4b)$$

where, as before, $p_{CDS,t}$ implies the sovereign CDS spread, and $p_{CS,t}$ implies the sovereign foreign currency bond credit spread at date *t*. The first, parenthetical expression on the right side of equations (4a)-(4b) implies the error correction mechanism through which the sovereign credit spreads evolving in the two markets cointegrate in the long run. Parameters α and β of the error correction coefficient are the equivalent of the parameters of the cointegration equation presented in the previous section.

Based on the λ_1 and λ_2 parameters of equations (4a)-(4b), we can gauge which market is primarily responsible for the price discovery of the sovereign credit spread. If the price of a country's credit risk is primarily determined in the foreign currency bond market, the credit spread will always change first in this market; CDS spreads will only adjust later, incorporating the changes in foreign currency bond yield spreads retrospectively. In terms of the error correction model of (4a)-(4b), if the foreign currency bond spread (p_{CS}) changes at date *t-1,* the error correction component of the equations moves from zero, its expected long-term value. If the foreign currency bond spread widens (narrows), as a result of the negative coefficient of parameter β, the value of the error correction component will be negative (positive). CDS spreads will adjust to the changes in the foreign currency bond yield spreads at date *t,* i.e. the value of parameter λ_1 of equation (4a) will be significantly negative.

However, if the CDS market leads in price discovery, changes in the price of credit risk will be first incorporated in the CDS spreads, while the foreign currency bond market will lag, and bond yield spreads will adjust with delay. In this case, as a result of a widening (narrowing) of CDS spreads (p_{CDS}) at date *t-1,* the value of the error correction component will be positive (negative). Foreign currency bond yield spreads will adjust to the changes in the CDS spreads at date *t,* i.e. the value of parameter λ_2 of equation (4b) will be significantly positive. If the CDS spreads and foreign currency bond spreads cointegrate, at least one market should follow the lead of the other market in terms of the pricing of credit risk, which means that at least one of parameters λ_1 and λ_2 should be statistically significant.

In addition to Hungary, we extended the analysis focusing on the primary market of price discovery to the ten emerging countries examined in Section 3.4. We were able to estimate the (4a)-(4b) error correction model for every country and every period where a cointegrating relationship was found between the CDS spreads and the foreign currency bond yield spreads. The existence of cointegration makes it possible to interpret the values computed for parameters λ_1 and λ_2, independent of the values of the cointegration parameters. For our estimates of equations (4a)-(4b), however, the restriction of β=1 was imposed again for those countries and periods, where in Section 3.4 we found a cointegrating relationship between the CDS spreads and foreign currency bond spreads even under this restriction. Similar to the cointegration analysis in Section 3.4, our examination of the primary market of price discovery was conducted on daily data for the periods of 3 January 2005 to 30 May 2008 (890 observations per country and per market), 2 January 2006 to 30 May 2008 (630 observations), and 2 January 2008 to 30 May 2008 (108 observations).

In the case of Hungary, in the period 2005-2008 parameters λ_1 and λ_2 were both significant, which means that both markets contributed to the price discovery of the sovereign credit spread (Table 3). In contrast, in the periods starting with 2006 and 2008, only λ_2 remained significantly positive, while the value of parameter λ_1 was not significant. This means that in the period between the beginning of 2006 and May 2008, **it was primarily the Hungarian sovereign CDS market where price discovery of Hungary's credit spread took place, i.e. new information regarding the credit risk of Hungary was first incorporated in the CDS spreads. In contrast, the foreign currency bond market was not an effective market considering that foreign currency bond yield spreads merely followed the changes of CDS spreads**. Based on the values of parameters λ_1 and λ_2, during the period of 2008, this trend appeared to strengthen even further. The

Table 3

Contribution of the foreign currency bond market and the CDS market to the price discovery of sovereign credit risk

	2005–2008		2006–2008		2008	
	λ_1	λ_2	λ_1	λ_2	λ_1	λ_2
Hungary	-0.023*	0.011*	-0.024	0.021*	-0.044	0.083*
Brazil	-0.083*	0.009	-0.063*	0.023	-0.175*	0.044
Republic of South Africa	-0.025*	0.041*				
Croatia	-0.032*	0.007	-0.032*	0.008	-0.243*	0.026
Latvia					0.005	0.097*
Lithuania					0.035	0.161*
Poland	-0.014	0.016*	-0.006	0.026*	0.009	0.086*
Romania	-0.044*	0.007	-0.042*	0.005	0.036	0.054*
Slovakia	-0.022*	0.009	-0.026*	0.008	-0.057	0.102*
Turkey	-0.002	0.017*	-0.033	0.035*	0.037	0.088*
Ukraine	-0.145*	0.005	-0.133*	0.003	-0.211*	0.054

The table contains the estimated values of parameters λ_1 and λ_2 of equations (4a)-(4b) for individual emerging countries.
*The * sign indicates significant parameters at 5 per cent level.*

significant λ_1 parameter observed in the period 2005–2008 is probably due to the fact that the liquidity of the Hungarian sovereign CDS market did not surpass – or even lagged behind – the liquidity of the Hungarian sovereign foreign currency bond market, thus any new information regarding Hungary's credit risk was first captured in foreign currency bond yield quotes. However, based on the results of the sample periods, the Hungarian sovereign CDS market clearly became the leader in price discovery from 2006, with its dominance strengthening over time.

Based on the values shown in Table 3, our analysis of the other emerging countries detected both similarities and differences compared to our findings for Hungary. For the periods 2005–2008 and 2006–2008 we did not observe any change in the sample countries comparable to what took place in Hungary. In most countries (Brazil, Croatia, Romania, Slovakia and Ukraine) the sovereign foreign currency bond market was the leader in the price discovery process for both periods, while in the cases of Poland and Turkey, the CDS market contributed the most. Regarding the Republic of South Africa, only the period 2005–2008 was suitable for estimation of the error correction model; and based on the result of this estimation both markets contributed to the pricing of credit risk. In the period starting in 2008, however, a significant change could be observed at an international level: throughout this period the sovereign CDS market became the leader in price discovery in seven countries out of the 10 emerging countries (in addition to Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Turkey) and only in Brazil, Croatia and Ukraine did the sovereign foreign currency bond market retain its position as primary contributor. This means that in 2008 the price discovery of the credit spread reversed direction in Romania and Slovakia. This may be explained in part by the fact that, as opposed to Hungary, in these countries it was not until the end of 2007 or the beginning of 2008 that the liquidity of the CDS market started to significantly surpass the liquidity of the foreign currency bond market. There may also be a technical reason behind this dissimilar result, which contradicts the anecdotal information provided by market participants. It is conceivable that from 2006 new information regarding the credit spread was incorporated first in the CDS spreads in these countries as well, but that may have resulted in more volatile CDS spreads than the spreads computed from the lower liquidity foreign currency bond market yield quotes. If the CDS spreads were subject to varying positive and negative shocks as a result of the new information, and they fluctuated around the foreign currency bond yield spreads which are more stable in time (albeit carrying less information), then the error correction model we applied will interpret the process as if it were the CDS spreads that invariably adjusted to the foreign currency bond yield spreads, when in reality the bond spreads appeared more stable because of their slow response only, and not because they led the price discovery process. On the whole, we may conclude that **looking back on a longer period of time, foreign currency bond yield quotes primarily contributed to the sovereign credit pricing of most emerging countries. From the end of 2007/beginning of 2008, when market participants reported that the turnover of the CDS markets of these countries reached a**

sufficient level of growth, the sovereign CDS market took over the leading role in the pricing of the credit spread, similar to the Hungarian situation.

In recent years, several empirical studies have been published, which focus on the relationship between different bond markets and the related CDS markets in the context of credit spread pricing; therefore, it is a useful exercise to compare their findings to ours and see what conclusions can be drawn. The initial analyses examined the relationship of corporate bond markets and CDS markets. Since they positively concluded that the CDS market contributed more to price discovery than the bond market as early as the first half of the 2000s, we consider their results particularly interesting. Blanco et al. (2003) and the ECB (2004) found respectively that for 25 corporations out of 27, and 10 corporations out of 15, the CDS market led credit spread pricing, as opposed to the bond market, which significantly contributed to price discovery in a few cases only. In addition, the ECB (2007) found that in subsequent years, the leading role of the CDS market became even stronger relative to the initial findings of ECB (2004). As noted in Section 2, the CDS markets related to corporate bonds acquired sufficient liquidity levels considerably earlier than sovereign markets, which might explain why these early studies found that the CDS market was the main forum for price discovery.

Similar to this study, In et al. (2007) and Ammer and Cai (2007) analysed the relationship of the foreign currency bond markets and CDS markets of emerging countries by means of error correction models. These analyses also suggest that the sovereign CDS markets in emerging countries tend to dominate price discovery, albeit to a lesser degree than was the case with corporate debt markets. This result is consistent with our findings regarding the period beginning in 2008, as opposed to the results of our analyses stretching further back in time, which in fact suggested the opposite. These two studies, however, focus on mainly Latin American countries, with little overlap to the countries analysed in our paper. The sovereign CDS market might have become sufficiently liquid earlier in these countries than in the typically smaller countries we focus on, which could account for the contrasting results we found regarding the longer period.

In et al. (2007) examined seven emerging countries in the period 1 May 2003 to 1 April 2006. According to their findings, the CDS market led the price discovery process in four countries and the foreign currency bond market led the process in three countries. Out of the seven countries in their study, two are also examined by us – Brazil and Turkey. According to the study, credit spread is priced exclusively in the CDS market in Brazil, and exclusively in the foreign currency bond market in Turkey. This result contradicts our findings; as we have described in this section, we found evidence of a completely opposite, robust correlation between the markets of these countries. The contradicting results may be attributed to the different sample periods used by the studies; it is possible that the relationship between markets changes over time. Second, conflicting results may be an indication that the modelling we applied is particularly sensitive to the data and method we used to estimate the foreign currency bond credit spread. Ammer and Cai (2007) also examined seven emerging countries in the period 26 February 2001 to 31 March 2005, and found, similar to the previous study, that in four cases the CDS market, while in three cases the foreign currency bond market led price discovery. This study, again, covers Brazil and Turkey among the countries we examined, and its findings in relation to these countries are more in line with our conclusions. While Ammer and Cai (2007) observed that both the foreign currency bond market and the CDS market contributed to the price discovery of credit spreads in both countries, their findings also suggested that in Brazil, the main contributor was clearly the foreign currency bond market, as opposed to Turkey, where the CDS market played the leading role. Thus the final conclusion of this study regarding these two countries is consistent with our findings.

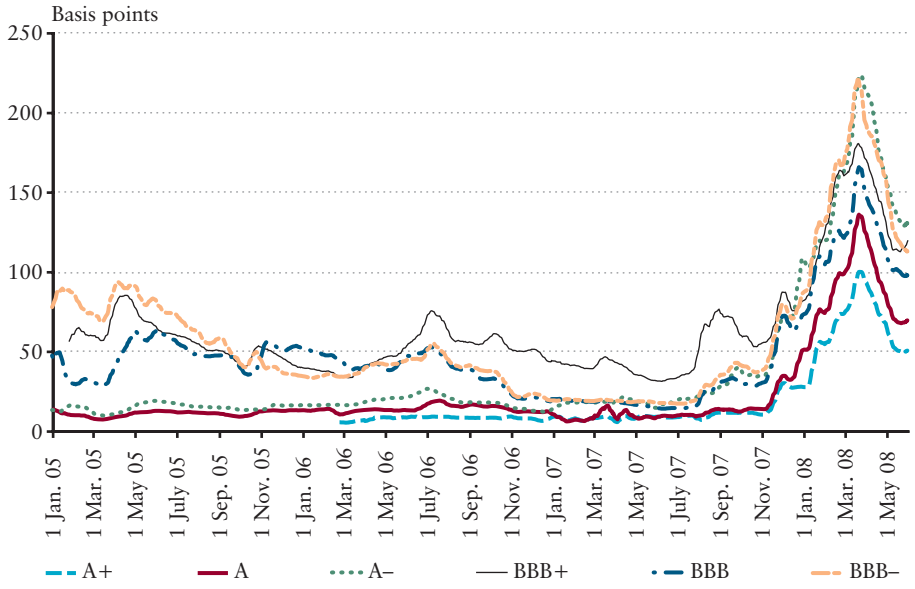
3.6 THE RELATIONSHIP BETWEEN THE HUNGARIAN SOVEREIGN CDS SPREADS AND THE CREDIT RATING OF HUNGARY IN INTERNATIONAL COMPARISON

In the previous sections we examined the information content of Hungarian sovereign CDS spreads primarily in a relative sense, i.e. relative to the yield spread of Hungarian sovereign foreign currency bonds. In this section we attempt to obtain information from analysing the relationship between Hungarian sovereign CDS spreads and the credit rating of Hungary in international comparison. For our calculations we use the 5-year CDS spreads of the same 15 emerging countries as above, and the average credit rating of these countries based on the average ratings of Moody's and Standard & Poor's (S&P).

As Chart 4 demonstrates, in the period starting in 2005 the five-year average CDS spreads of emerging countries with the same credit rating often did not relate to the average value of the other credit rating categories as they should have based on the specific credit rating category. For example, the average CDS spread of countries rated A- and BBB+ was often

Chart 4

Average five-year CDS spreads in the credit rating categories of emerging countries



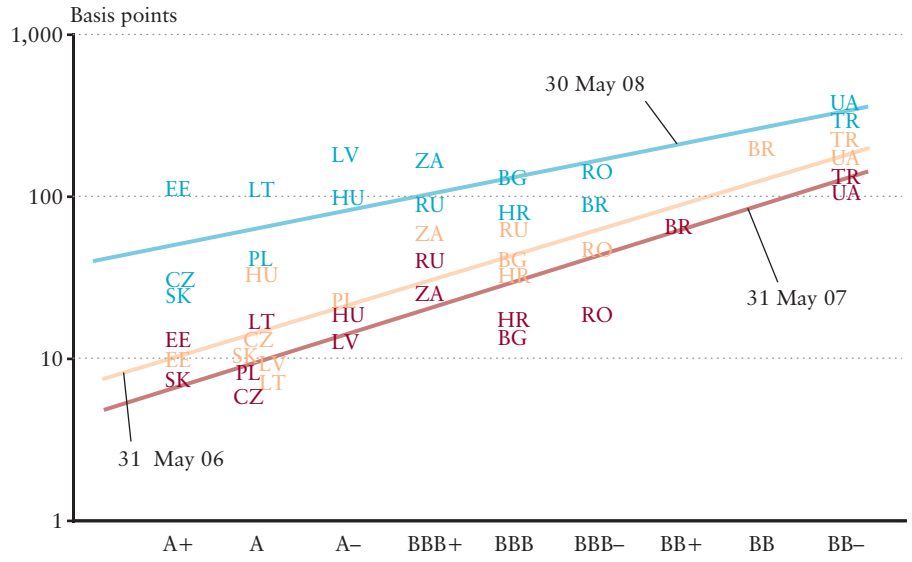
Source: Datastream, Bloomberg, own calculations.

significantly higher than the average CDS spread of lower rated, BBB and BBB- category countries, which have higher credit risk. This inconsistency may be attributed to several different reasons, and does not necessarily imply that in general the CDS spreads of emerging countries do not realistically reflect different levels of sovereign credit risks in the long run. This issue is of particular importance to us because, as Chart 4 demonstrates, the 5-year CDS spread of the A- rating category appears to be the most distorted in international comparison, and that rating includes Hungary.

Chart 5

Credit ratings and five-year CDS spreads of emerging countries

(on a logarithmic scale, on specific days)



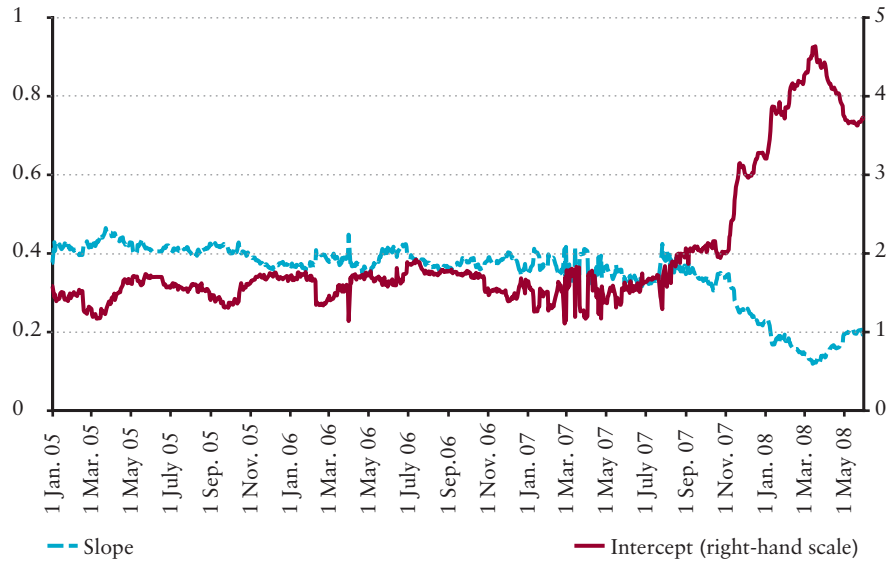
Source: DataStream, own calculations.

One, we used the average figure of two credit rating agencies; if their ratings differ from one another, market participants may decide which rating they consider more realistic and their pricing will reflect that rating. Two, we disregarded the positive, negative or neutral outlooks of the credit agencies, as their inclusion would have resulted in only one country being typically placed in a category. The different outlooks, however, have a significance, which may be measured in several basis points in market pricing. Three, upgrading or downgrading actions of the credit rating agencies often lag behind market perceptions with respect to the credit quality of a country. Four, as we found in the previous sections, the CDS market appears to be efficient in some emerging countries and inefficient in others; hence the quality of the information content of CDS spreads might also vary from country to country. Five, even by disregarding the outlooks, only two or three countries were placed in each category, meaning that a country's potentially extreme values may have significantly distorted the value of the average CDS spread in the relevant category. Even though these factors may not affect more than one or two of our sample countries, they distort the consistency of Chart 4 as a whole, and we can eliminate this distortion by observing, at each point in time, the common information we can gain from the relationship of the CDS spreads and credit ratings of specific emerging markets, and examining the individual values of each country relative to that common information.

In order to achieve this, as Chart 5 indicates, we estimated a regression for each day of the sample period between the five-year CDS spreads and the credit ratings of emerging countries. According to general market experience, deterioration of the credit rating between categories is usually not followed by a linear changing of credit spreads, because market participants demand increasing expansion in risk premia when credit quality declines, especially as the credit rating approaches non-investment grade categories. Therefore, the regression was computed for the logarithm rather than the level of the five-year CDS spreads.

Chart 6

Daily changes of the slope and the constant term of the linear regression between the credit ratings and the logarithms of five-year CDS spreads of emerging countries

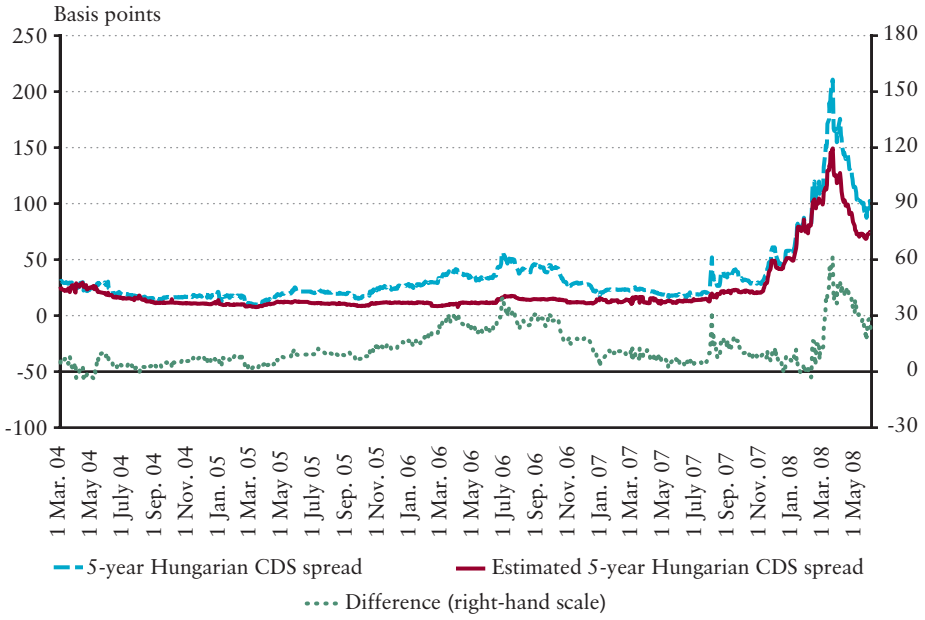


Source: Own calculations.

The slope of the daily regression lines was positive throughout the sample period (Chart 6). This means that on the whole the five-year sovereign CDS spread levels of the emerging countries in our sample were consistent with the credit ratings of individual countries, as the expected CDS spread of lower rated countries is wider than that of countries with a better credit rating. The slope of the regression lines remained steadily around 0.4 until the end of 2007; from the end of 2007, however, the slope began to flatten and the constant term of the regressions started to rise. Since, due to the non-linear relationship between credit quality and credit spread, we ran the regression on the logarithm of CDS spreads, this change indicates an overall, significant widening of the credit spreads across all credit rating categories from the end of 2007, as demonstrated by Chart 4. On 13 March 2008 the slope of the estimated regression line reached its most flat position in the sample period, 0.12; however, with a p value of 0.009 even this figure implies a statistically significant positive slope at all standard significance levels.

Chart 7

Deviation of the five-year Hungarian CDS spread from the regression line between the credit ratings and five-year CDS spreads of emerging countries



Source: Datastream, own calculations.

With respect to Hungary, based on the parameters of the daily regressions between the credit ratings and five-year CDS spreads of emerging countries, we estimated what would have been the size of the five-year Hungarian sovereign CDS spread on each day of the sample period. From the beginning of 2004, we could only identify two periods through which the five-year Hungarian CDS spread steadily exceeded the regression line between the credit ratings and five-year CDS spreads of emerging countries by more than 10-15 basis points (Chart 7): for the most part of 2006 and in the period March–April 2008. **With the exception of these two periods, the size of the five-year Hungarian sovereign CDS spread was essentially consistent with the correlation we observed between sovereign credit ratings and the level of sovereign CDS spreads in emerging countries, therefore it was a fundamentally reliable measure of the Hungarian sovereign credit spread.**

Concerns regarding the fundamentals of the Hungarian economy in general and the sustainability of the budget deficit in particular became particularly strong among investors during the election year of 2006. This process is well reflected in the gradual widening of CDS spreads in a CDS market, whose liquidity only just started to pick up during this very period. In June 2006 the S&P downgraded Hungary's existing A- credit rating to BBB+ but Moody's did not downgrade Hungary's A1 credit rating to A2 until December 2006, which, even at the lower rating, was still two categories higher than the rating set by S&P. Thus the widening observed in 2006 is primarily attributable to market participants' worse perception of the credit risk of Hungary than would have been justified by the existing value of the average credit rating applied in our analysis; they therefore demanded a wider CDS spread that would have been reasonable for the average Hungarian credit rating based on the parameters of the international regression.

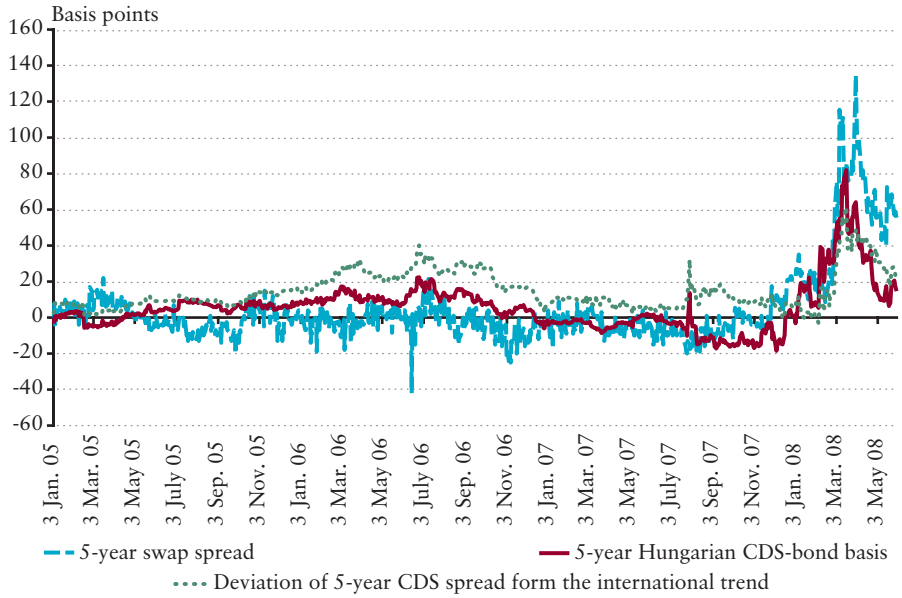
The highest extent to which the size of the Hungarian sovereign CDS spread surpassed the regression line between the credit ratings and five-year CDS spreads of emerging countries was observed during the period March–April 2008; by the middle of March the difference amounted to 60 basis points. Nevertheless, in view of Chart 7 we should note that, based on the parameters of the regression between the credit ratings and five-year CDS spreads of emerging markets, **the overall surge in the CDS spreads of emerging countries across all credit rating categories provided justification for the hike of the five-year Hungarian sovereign CDS spread to 150 basis points in the period March–April 2008.** In the middle of March the five-year Hungarian sovereign CDS spread exceeded this value of 150 basis points which had been justified by global processes, and increased by another 60 basis points; and while CDS spreads subsequently started to decrease, it was

not until the end of April that the difference dropped to below 30 basis points. Thus **this 30-60 basis point portion of the five-year Hungarian sovereign CDS spread increase should be considered a country-specific factor, which cannot be attributed to the overall growth of credit spreads observed in global markets.** This country-specific growth was exceptional because, in addition to the fundamental reasons noted above (investors had more negative perceptions regarding Hungary's credit risk than the official ratings of credit risk agencies), technical factors also played a part. According to the information provided by market participants, the effects of a significant liquidity decrease and liquidity premia growth observed during the same period in the secondary market of forint government bonds are behind the technical factors.

At the end of February and at the beginning of March 2008, a substantial growth in yields was observed in the secondary market of longer term, forint-denominated Hungarian government securities, with a simultaneous, significant decline in the market's liquidity. As a consequence, a high liquidity premium was incorporated in forint government security yields, forcing the government bond yields to depart from the yields prevailing in the still liquid interest rate swap market, which lead to a widening of the interest rate swap spread. Indeed, it was when the interest rate swap spread also started to jump that the deviation of the five-year Hungarian sovereign CDS spread from both the five-year Hungarian foreign currency bond yield spread and from the regression line between the credit ratings and five-year CDS spreads of emerging countries became the most dramatic (Chart 8).

Chart 8

The five-year Hungarian interest rate swap spread and the deviation of the five-year Hungarian CDS spread from the foreign currency bond yield spread and the regression line between the credit ratings and five-year CDS spreads of emerging countries



Source: Government Debt Management Agency, Reuters, Datastream, Bloomberg, own calculations.

The growth in forint-denominated government bond yields can be often attributed to fundamental factors which also trigger the growth of Hungary's credit spread. Investors who are equally active in the government bond market and the CDS market may take advantage of this correlation in cases when the shrinking liquidity of the domestic government bond market prevents them from selling their government bonds, which would allow them to reduce their Hungarian credit risk exposure. Since the liquidity of the domestic government bond market is generally sufficient under normal market conditions, the above cases primarily occur in a turbulent market environment.

If investors who are active in both markets fail to sell their forint-denominated government bonds, they might attempt to cover their positions via the purchase of CDS contracts, speculating that the growth of government bond yields will be followed by a widening of the CDS spreads. Through their CDS purchases, however, these investors also facilitate an abrupt surge in the CDS spreads. Thus an abrupt growth in the liquidity premium of the forint-denominated government bond

market will have a negative effect on the pricing of CDS spreads through the above channel. While in these cases the widening of the CDS spread (i.e. the price of Hungary's credit risk) is justified to a certain extent, **through the transactions of investors who are active in both markets, a portion of the CDS spread growth is related to the shrinking liquidity of the domestic forint government bond market, rather than to the growth of Hungary's credit risk. During turbulent market periods this relationship between the government bond market and the CDS market may lead to the overshooting of CDS spreads.**

4 Conclusions

The most active participants in the Hungarian sovereign CDS market include global investment banks, hedge funds and other non-resident fund managers. CDS contracts with five-year maturity are considered the most liquid. The liquidity of the market is low relative to the average liquidity of credit derivatives markets; based on the number of quotes, it is situated in the lowest quarter of sovereign CDS markets. Nevertheless, credit derivative brokers receive 30-40 binding Hungarian sovereign CDS quotes on a daily basis, from an average of ten banks. Based on this, the daily turnover of the Hungarian sovereign CDS market amounts to at least EUR 10-20 million, and at the end of 2007 the total nominal amount outstanding of Hungarian sovereign CDS contracts was around USD 10-30 billion (EUR 7-20 billion). Relative to USD 21 billion, i.e. the total amount outstanding of foreign currency bonds issued by the Hungarian government as of the end of 2007, this value indicates that the Hungarian sovereign CDS market is a significant market from a Hungarian perspective.

The Hungarian sovereign foreign currency bond market and the CDS market are in a close relationship. During our sample period the five-year Hungarian sovereign CDS spread and the five-year Hungarian foreign currency bond credit spread characteristically moved in tandem, and accordingly the CDS-bond basis fluctuated close to zero for the most part of the period under review.

In addition, the results of our cointegration analysis reconfirmed that the Hungarian sovereign CDS spread and the foreign currency bond credit spread cointegrate in the long run; however, the two prices may temporarily deviate from one another due to transaction costs, differing market liquidity and additional microstructural factors. Of the two prices of the Hungarian credit risk, the CDS spread proved to be the most volatile in the past; over a long-term time horizon, a 1 basis point change in the foreign currency bond credit spread was accompanied by a 1.6-2 basis point change in the CDS spread, which might indicate that the liquidity of the Hungarian sovereign CDS market surpasses that of the Hungarian sovereign foreign currency bond market.

According to our error correction analysis, the price discovery of the credit risk premium of the Hungarian government takes place primarily in the Hungarian sovereign CDS market, which means that any new information pertaining to Hungarian credit risk is captured in the CDS spreads first. In contrast, the foreign currency bond market is not an effective market considering that foreign currency bond yield spreads merely follow the changes of CDS spreads.

For most of our sample period the size of the five-year Hungarian sovereign CDS spread was essentially consistent with the correlation observed between the sovereign credit ratings and the sovereign CDS spreads of other emerging countries: it was a fundamentally reliable measure of the Hungarian sovereign credit spread. In view of the general growth in the CDS spreads of emerging countries across all credit rating categories, a large proportion of the Hungarian CDS spread growths was justified, even during the turbulent market period observed in March-April 2008. In excess of this justifiable growth, however, we observed a country-specific growth of 30-60 basis points in the five-year Hungarian CDS spread during the same period. A portion of this surge may be considered as an overshooting of the CDS spread, resulting from the growth of liquidity premia in the forint government bond market, which was triggered by the trading behaviour of investors equally active in the domestic forint government bond market and in the Hungarian sovereign CDS market.

References

Ammer, John and Fang Cai (2007): "Sovereign CDS and Bond Pricing Dynamics in Emerging Markets: Does the Cheapest-to-Deliver Option Matter?", Board of Governors of the Federal Reserve System, *International Finance Discussion Papers* No. 912.

Csávás, Csaba, Lóránt Varga and Csaba Balogh (2007): "The forint interest rate swap market and the main drivers of swap spreads", *MNB Occasional Papers* 64.

Barret, Ross and John Ewan (2006): *BBA Credit Derivatives Report* 2006, British Bankers' Association.

BIS (2007): *Triennial Central Bank Survey, Foreign exchange and derivatives market activity in 2007.*

BIS (2008): *Regular OTC Derivatives Market Statistics.*

Blanco, Roberto, Simon Brennan and Ian W. Marsch (2003): "An empirical analysis of the dynamic relationship between investment-grade bonds and credit default swaps", *Bank of England Working Paper* No. 211.

ECB (2004): *The euro bond market study.*

ECB (2007): *The euro bond market study.*

Hull, John, Mirela Predescu and Alan White (2004): "The relationship between credit default swap spreads, bond yields, and credit rating announcements", *Journal of Banking & Finance* No. 28.

In, Francis, Byoung Uk Kang and Suk Tong Kim (2007): "Sovereign credit default swaps, sovereign debt and volatility transmission across emerging markets", *Korea Advanced Institute of Science and Technology Working Paper Series.*

ISDA (2008): *ISDA Market Survey.*

JPMorgan (2006): *Credit Derivatives Handbook.*

Packer, Frank and Chamaree Suthiphongchai (2003): "Sovereign credit default swaps", *BIS Quarterly Review,* December 2003.

Wit, Jan De (2006): "Exploring the CDS-Bond Basis", National Bank of Belgium, *Working Paper Research* No. 104.

MNB Occasional Papers 78.
The information content of Hungarian sovereign CDS spreads

May 2009

Print: D-Plus
H–1037 Budapest, Csillaghegyi út 19–21.