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Final Thesis

The Corporate/Treasury Bond Spread In China

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1. Introduction

China's still young bond market has become the world's third-largest bond market. Its growth has been very rapid but has not yet adjusted to the size of its economy. As in many other emerging economies in China, after the great financial crisis, companies preferred to finance themselves in an alternative way to classic bank financing and classic stock issuance. From this moment on, the bond market has developed a lot, thus obtaining a main role for the financing of companies. Over the past two decades, the bond market, both treasury and corporate, in China has grown very rapidly. Unfortunately, the literature and research concerning these two markets is very poor, in the case of corporate bonds almost non-existent. My research aims to fill the hole by focusing on the spread between Chinese treasuries and corporate bonds. By studying the three fundamental parameters that usually characterize yield curves, which are slope, curvature and level, and studying their interactions I will try to understand if these significantly explain the movement of returns. The observations used for this study start from March 2006 and arrive in May 2017, these are weekly data. To calculate the three fundamental parameters, I used the data collected regarding Chinese treasury bonds and corporate bonds at different maturities.
I studied the three parameters previously mentioned by carrying out analysis on the parameters themselves and their interactions, also trying to understand if they are related, both for the same market and across markets.

First, I divided the sample of data found into two distinct samples, thanks to the study of breakpoint. The two samples are respectively: 03/01/2006-06/29/2009 and 06/30/2009-05/10/2017

The yield curve provides us with the relationship between the maturity of a bond and its rate. I broke down the yields of bonds with different maturities into the three common factors I mentioned above. To be able to understand how this yield curve moves, I analyzed the trend of these factors over time. The levels factor gives us an interpretation of the average yield of the yield curve, the slope, on the other hand, is interpreted as the difference between long-term and short-term yields. Finally, curvature tells us how the interest rate varies in the long run compared to the medium-term rate.

I then detected the long-term relationships between each parameter between the markets by evaluating two distinct samples, chosen on the basis of the analysis of the breaks, evaluating their stability.

I mainly get some results. First, I found a long-term relationship regarding the third factor, namely curvature. This relationship is verified in both samples, therefore throughout the sample period chosen for this study, from March 2006 to May 2017. Unfortunately, such a relationship is not so relevant because it only shows that the curvatures of the two yield curves have a long-term relationship. This means that there is a relationship regarding the way the long-term interest rate varies relative to the medium-term rate for both yield curves, both treasury and corporate.

An interesting result of this research concerns only the first sample analyzed (03/01/2006-06/29/2009). I found a long-term relationship between the first parameter of the yield curve of Chinese treasury bonds and the first parameter of the yield curve of Chinese corporate bonds, taking both in first difference. In particular, the long-term coefficient is not only significant, but it also has such a high value (a value that is very close to 2). This tells us that Chinese treasury bonds significantly influenced Chinese corporate bonds.

Unfortunately, this is a valid result only for the first sample, so we cannot generalize it to the entire sample period.
With this paper I contribute to the literature concerning the study of the relationship between the yield curve of Chinese Treasury bonds and the yield curve of Chinese corporate bonds, going to look at the entire curve and not just at specific periods.

Using weekly data and a different estimate of the three latent factors, I tried to confirm or disprove the results obtained from previous studies. In fact, my results will differ from those obtained for three reasons. First, I got a long-term relationship (throughout the chosen sample period) between the corporate and treasury bond markets in China just for the curvature. Secondly, this relationship is confirmed for both markets, so the two curvatures affect each other. Thirdly, the structural break shows us that if we considered two different samples, the relationships between the two markets would be several and stronger.

The remaining part of this document is organized as follows. The next section provides a first presentation of the historical-economic context of China from the end of the 20th century to the present. The third section deals with the analysis of the data used for this research, starting from a more general background of the Chinese bond market and arriving at the actual analysis of the data. The fourth section presents the methodology used to extract the three fundamental parameters and to study their relationship. In the fifth section we find the results and finally in the sixth section I present the conclusions.

2. Review of literature

The yield curve is a graph which depicts how the yields on debt instruments, such as bonds, vary as a function of their years remaining to maturity. In the literature, the yield curve is often broken down through the use of a few very important factors. These are three: levels, slope and curvature. Term structure models have been widely applied to determine the term premium component in bond prices (Vasicek, 1977; Cox et al., 1985; Longstaff and Schwartz, 1992 is a short list).

In order to understand how the bond yield curve moves, it is necessary to observe how these factors change over time. The first parameter (level) gives us information regarding the average yield, the second parameter (slope) gives us the difference between long-term and short-term yields and finally the third parameter (curvature) tells us how interest rates change in the long term compared to the medium term. Currently, the literature concerning the interaction between the corporate and government bond markets has focused solely on considering how one market act as a benchmark for the performance of another market (as reported by Sun, Dunne and Li, 2015). Common factor models can be used to measure the contribution of these markets to the price discovery, here are some examples: i) The Gonzalo and Granger model which focuses on the components of the common factor and the error correction process ii) The Hasbrouck model which considers the contribution of each market to the variance of innovations with respect to the common factor (Hasbrouck, J. Finance (50) (1995) 1175); (Gonzalo and Granger, J. Bus. And with. Stat. 13 (1995) 27).

The closest paper to the current research is "Price discovery in china's corporate and treasury yield curves" (Girardin, Lunven and Chen, 2021).

The latter paper aims to contribute to the literature on corporate bond and treasury markets in China by focusing on the entire yield curve rather than on selected yield maturities. In the initial part of this paper there is an empirical estimate of the two yield curves through the study of the three latent factors, which are calculated through the Nelson-Siegel dynamic model. This work differs from the others already existing in that, firstly, it uses the Nelson-Siegel model to calculate the three fundamental parameters using the same sample (11 years from 2006) as in this dissertation with high frequency (daily) data. In the current dissertation I will use weekly data. Second, the paper studies both the treasury and corporate bond markets in China entirely. Thirdly, this paper does not only aim to study the predictions of the Treasury yield curve, but studies all the interactions, both short and long term, between the parameters of the treasury and the corporate yield curves themselves. By doing this, one can determine which of the corporate or treasury bond markets contributes to the discovery of prices for each parameter of the yield curves. Fourth, this paper for the first time in the Chinese bond literature introduces a structural breakdown analysis for such modeling of the yield curve factor.

Thanks to this study, it was shown that treasuries do not have a uniform guiding role in any way in providing a benchmark for all factors of the yield curve for China. The dominant role of government bonds appears only in the discovery of the slope of the yield curve. The leadership appears reversed for the level as the discovery was made by the corporate bond market in the entire sample from 2006 to 2017.

3. Presentation of the data

3. 1 Background of the Chinese bond market

Since 1997, china's bond market has seen a rapid development. To date, as previously mentioned, it is the third largest bond market in the world, which, has allowed it to become part of the global indices for emerging markets. The birth of the Chinese bond market dates back to 1861, when it broke into the foreign bond market. The Chinese very frequently used foreign bonds from 1861 to 1950 mainly so that the government financed the various wars. The first issue of Chinese bonds took place in 1950 with the Ministry of Finance, but the issuance has been interrupted in 1958 under the control of the central government. In 1979 China faced a great period of liberalization that led it to the resumption of bond issuance in 1981, the main reason being to finance domestic construction projects. From here began the period of China's great opening to the world, and the bond market provided significant capital during this process[1].

In the beginning, China had only a primary market, in which only new securities and bonds could be issued. Government bonds could not therefore be traded until a secondary market was started, only in selected cities, in 1988 and nationally then in 1990 when the Shanghai and Shenzhen stock exchanges were opened. Since 1996, negotiable government bonds could only be accessed through an auction system. In December 1996, a unified national bond custody and settlement system was established with the newly founded centralized securities depository, China Government Securities Depository Trust & Clearing Co., Ltd. In addition, the most powerful economic decision-making agency was created. China's secondary bond market consists of three submarkets: the exchange-traded market, the interbank market, and the over-the-counter (OTC) market. Until 1997, the exchange-traded market was the most active market and private investors together with commercial banks were the most active players. The latter were excluded from the exchange-traded market in 1997 and began trading on the interbank market. From this point on, secondary trading for Chinese government bonds has been greatly divided, with assets split between stock exchanges, the interbank market and the over-the-counter market. The latter has always represented only a small share of market activity.

Present day situation

There are six main types of instruments traded in the Chinese bond market: i) government bonds issued by the Ministry of Finance; ii) bonds of the People's Bank of China; iii) financial bonds issued by banks and financial

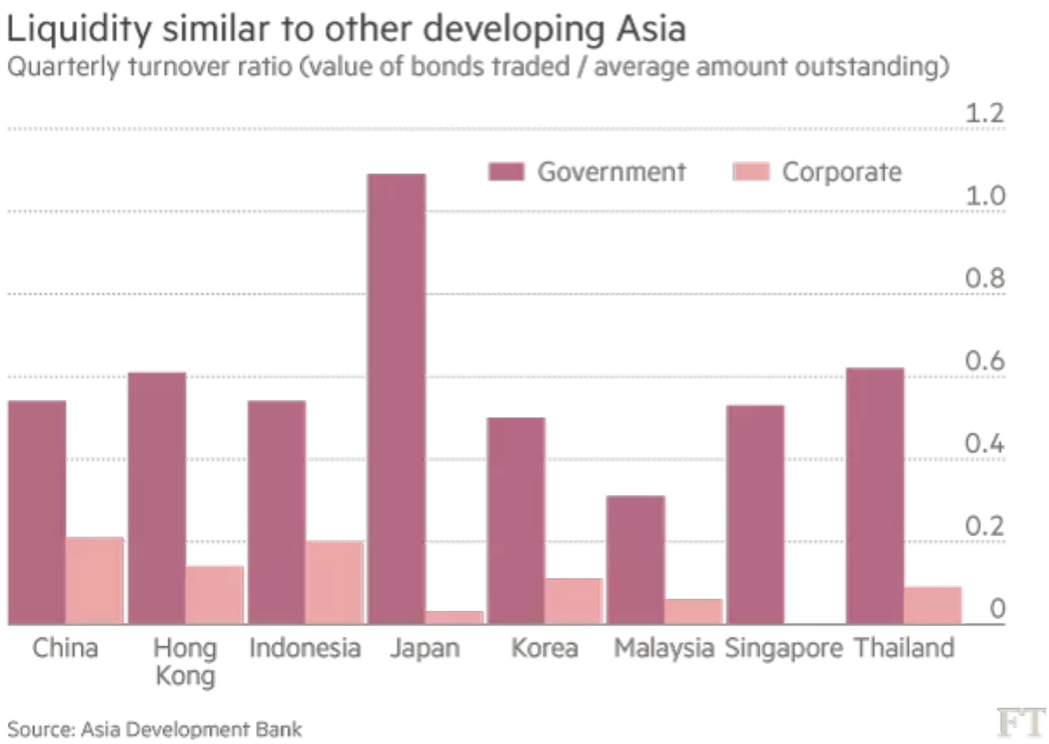
1 See Chirag D. Manyapu (2018).

institutions guaranteed by the government; iv) corporate bonds issued by domestic companies; v) commercial papers, issued by securities brokerage companies or private companies; and vi) medium-term securities.

Treasury bills are debt securities issued by the Ministry of Finance to raise funds for large development projects and to cover budgetary negatives. The financial bonds of the policy banks are issued by the three policy banks as the main source of funding. The three public banks are the China Development Bank, the Agricultural Development Bank of China and the Export Import Bank of China. The bonds of the companies are issued by state-owned enterprises or by foreign joint ventures in order to be able to win additional capital. Commercial papers are notes issued by companies to finance themselves in the short term, while medium-term bonds are issued, as mentioned above, by state-owned enterprises and other companies, if there has first been approval by the National Association of Financial Market Institutional Investors.

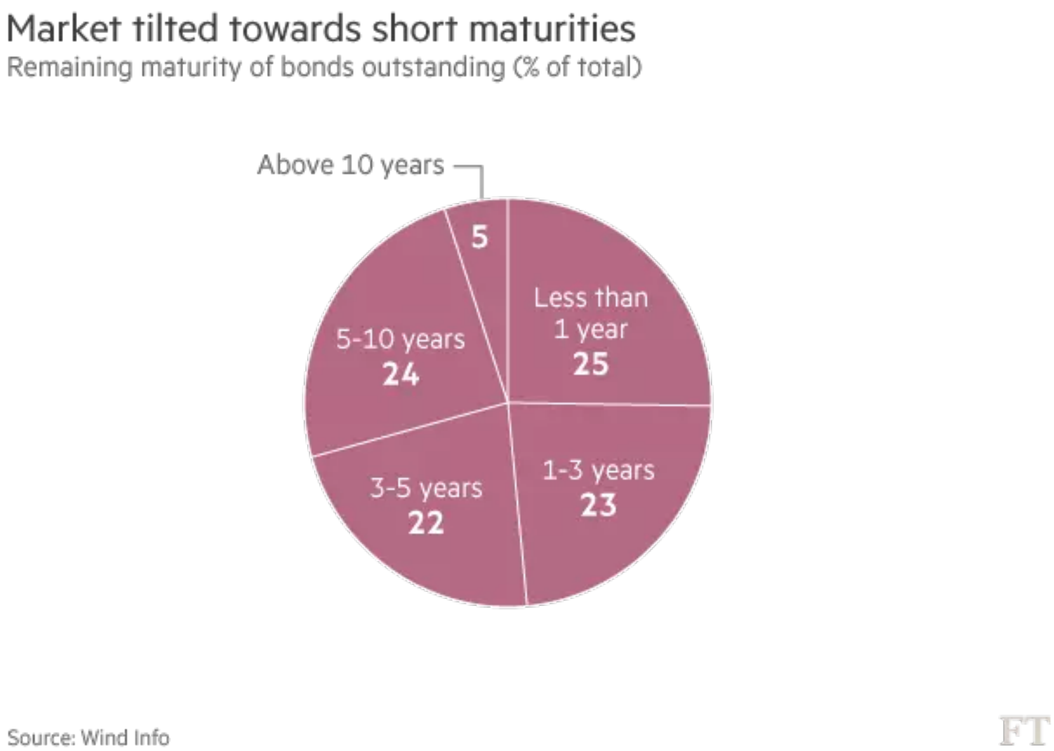
The overall liquidity of China's government and corporate bond market is comparable to the liquidity of other emerging bond markets in Asia. Within these, however, the ease with which bonds can be traded varies greatly. Many bonds have a short maturity, with banks and other traders holding them until their maturity. Among sovereign bonds, public bank bonds are often more liquid than treasury bills. Among corporate bonds, medium-term notes approved by the People's Bank of China are more liquid than corporate bonds overseen by the National Development and Reform Commission, the state's planning agency. The following graph (Graph.1), provided by the Asia Development Bank, shows us that China's liquidity is not as high compared to other Asian markets.

Graph.1 – Liquidity of Asian countries



The Chinese bond market usually has shorter maturities, as can be seen from the chart below (Graph.2): 25% of bonds have a maturity of less than one year and 70% have a maturity of less than 5 years. It is important to note that only 5% of bonds have a maturity greater than 10 years.

Graph.2 – Maturity of the Chinese bond market



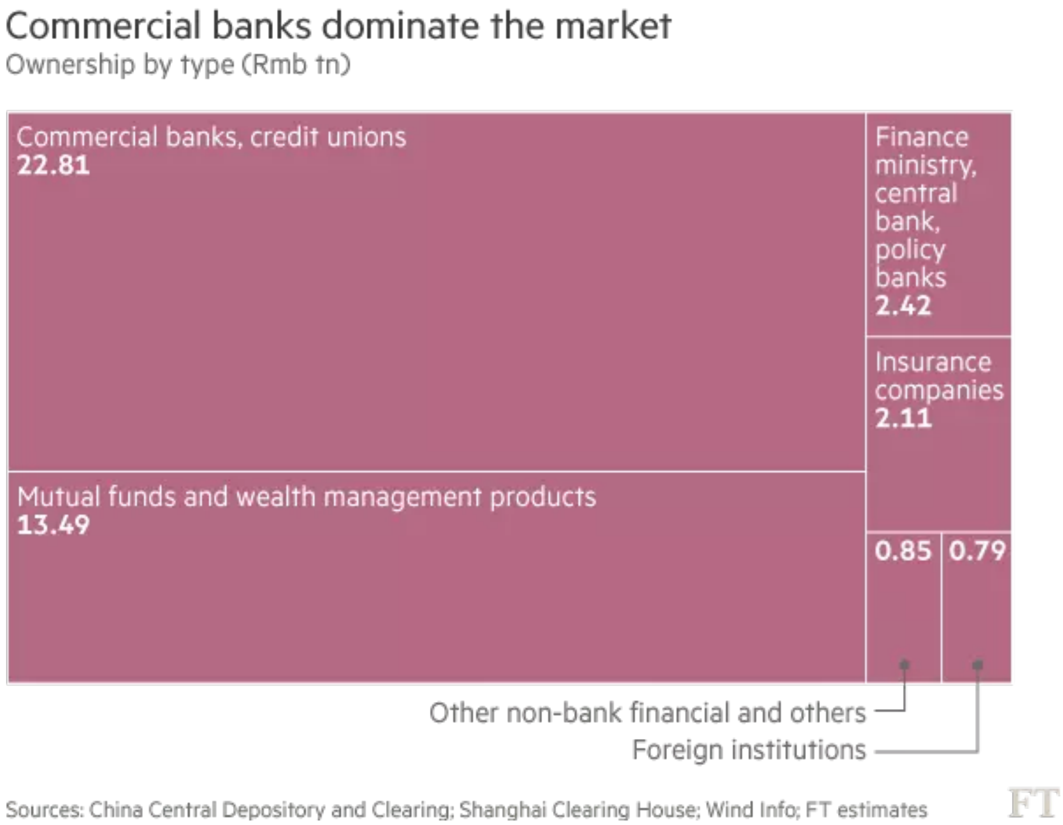
It is acknowledged that the Chinese bond market does not properly assess the risk of its assets. Many investors have the foolish certainty that the government will bail out borrowers in danger of insolvency, leading to moral hazard. It must be said, however, that in recent years insolvencies in China have increased greatly, weakening the notion of implicit government guarantee for all debt payments[2].

The four largest commercial banks own the largest share of Chinese bonds in order to reduce the risk of bank runs. China's central bank forces its commercial banks to hold a given amount of liquid assets because the latter are easier to sell when you need cash. Government bonds help commercial banks meet this demand from the Chinese central bank, as these are among the most liquid instruments in the Chinese market. Moreover, given the greater transparency of public rather than corporate debts, government-issued bonds are considered less risky.

The chart below (Graph.3) shows how commercial banks own 22.81 trillion RMB in Chinese bonds.

Graph.3 – Shares of Chinese bonds held by various entities

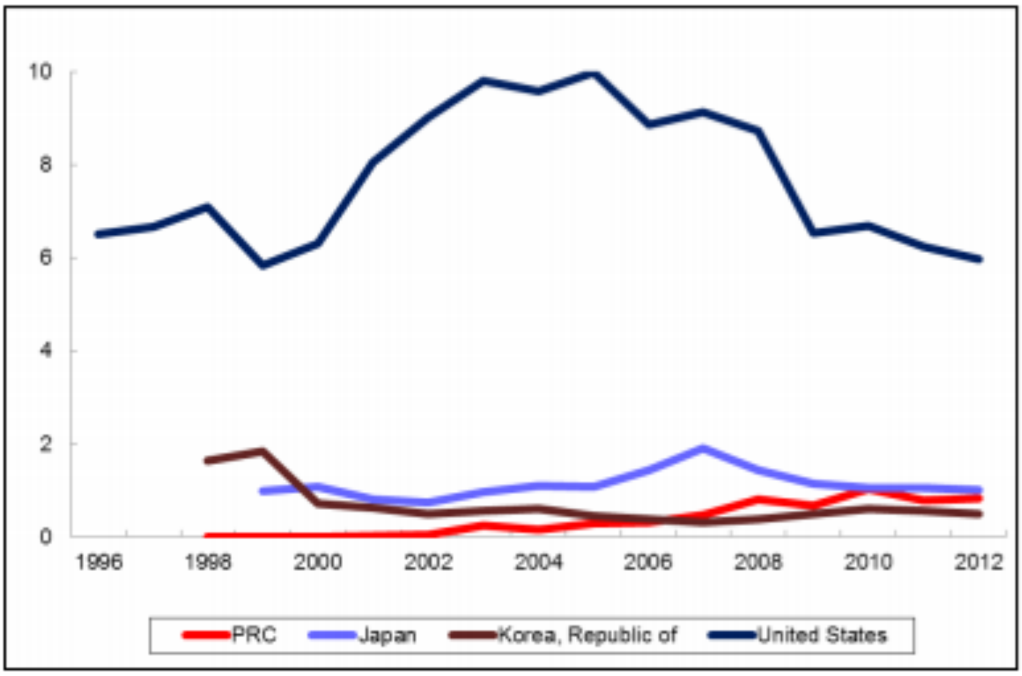
[2] See Chirag D. Manyapu (2018).



This predominance of the public sector in the Chinese bond market, in terms of total outstanding amount and issuance, could facilitate the internationalization of the renminbi in the short term. This is because public sector bonds are perceived as less risky due to, as we said, explicit or implicit guarantees from the government. Public sector bonds are also less diversified due to fewer issuers than corporate bonds. Given the weakness of China's bond market infrastructure and due to the lack of credible rating agencies, public sector bonds are more attractive to foreign investors, and foreign central banks tend to hold such bonds as foreign exchange reserves. There is, however, a limit to the number of bonds that the public sector can issue, and without corporate bonds, the development of China's domestic bond market would be strained. No doubt one way to increase the use of renminbi internationally is to encourage foreign investors to hold renminbi-denominated assets, which would also result in an increase in the Chinese corporate bond market.

Despite the enormous growth of china's bond market since 2000, this market is still not as active as that of other developed economies. In fact, if we compare it with the US bond market, we could see how the turnover of the Chinese bond market is much lower. This lower level could be explained by the fact that investors are less diversified and also by the fact that commercial banks have control over the bond markets.

Graph.4 – Chinese government bond turnover rate



As can be seen from the fourth chart (Graph.4) the turnover rate of Chinese government bonds is lower than that of economies with international currency although it is equal to or higher than in other economies. In 2012 the turnover of US government bonds was higher, which clearly indicates a highly liquid market.

The turnover ratio of Chinese corporate bonds has been higher than that of government bonds, as well as those of developed economies, including the United States with its very large and very liquid corporate bond markets. Compared to government bonds, corporate bonds are much more diversified in terms of maturity, coupon, default risk and bond covenants due to each unique company. This diversification means that corporate bonds are held to maturity, leading to lower turnover ratios[3]. Government bonds, on the other hand, may have much more standardized instruments, which make trading easier.

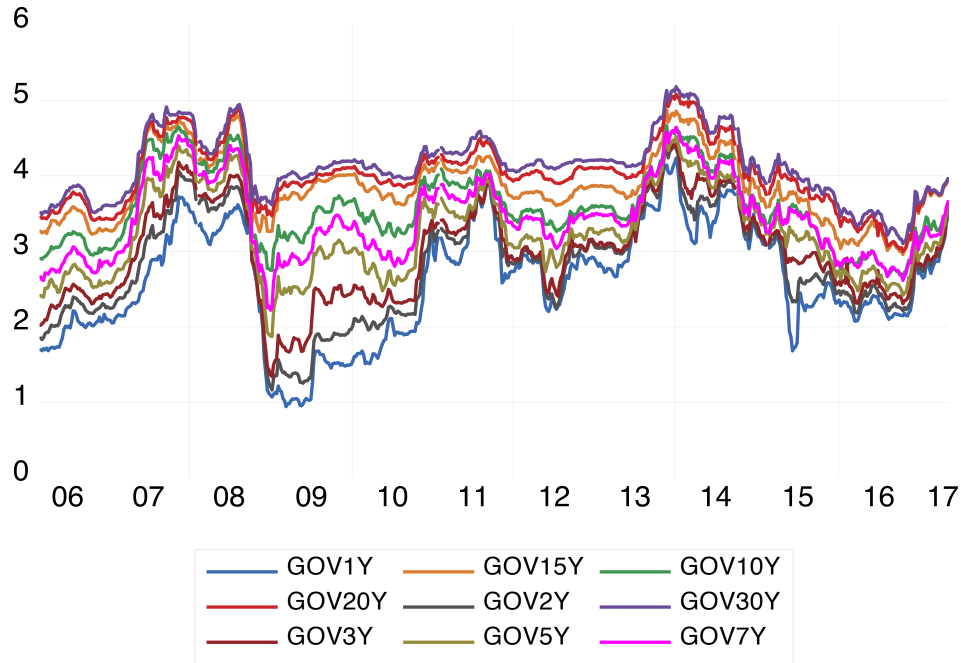
3. 2 Data analysis

To write this paper I used as starting data the yields (calculated on a weekly basis) of Chinese Treasury bonds and Chinese corporate bonds. For both types of bonds, I used all available maturities, so I used data for 1 year, 2 year, 3 year, 5 year, 7 years, 15 years, 20 years, 30 years returns. Thanks to these data I was able to build the three fundamental parameters of the performance curves: levels, slope, curvature. In my paper they will be called Beta0, Beta1 and Beta2 respectively (the computation of the three parameters is explained in section 4.1, calculation of the yield curve parameters). The parameter name will then be appended with "gov"," if it is the yield curve of Chinese government bonds, or "corp", if it is the yield curve of Chinese corporate bonds.

[3] See Chirag D. Manyapu (2018).

Below is the chart corresponding to the evolution of Chinese Treasury yields (Graph.5).

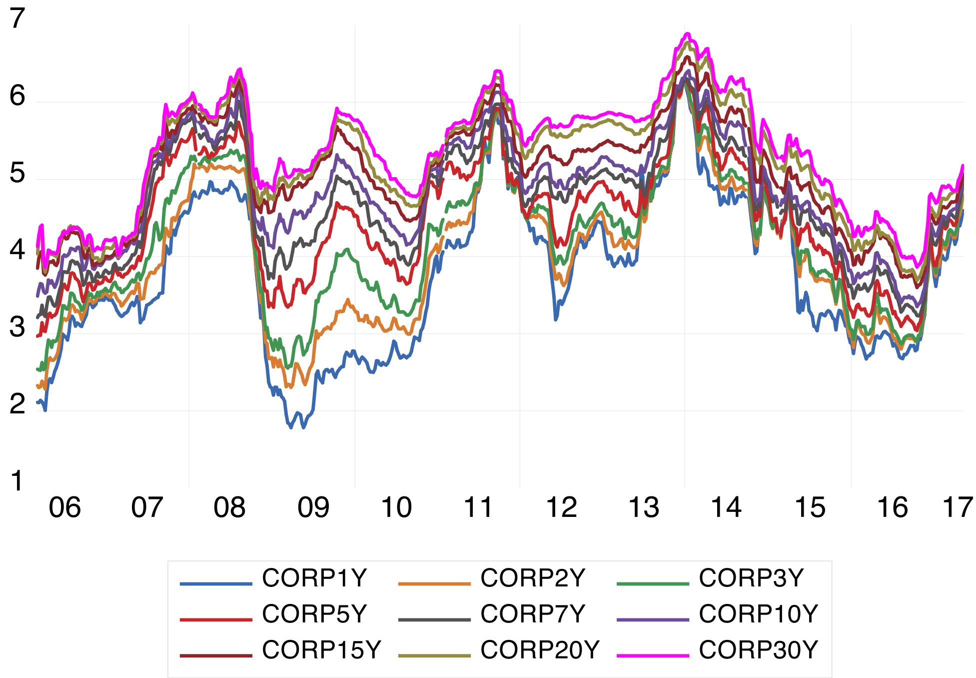
Graph.5 – Evolution of Chinese Treasury Bond Yields



As you can see from the graph the trend of these curves is slightly increasing in the period used, in fact the starting point differs by 0.5 percentage points from the chosen point of arrival. Basically, all curves follow the same trend, obviously with different yields depending on the maturity (longer maturity means higher yield). It is clear that the trough of 2008 is due to the great financial crisis, but equally important is the trough of Treasury bonds maturing one year in 2015. We will find this trough in Beta1_gov as a positive peak as the aforementioned parameter is calculated as the difference between bonds maturing 30 years and bonds maturing 1 year.

Below is the graph corresponding to the evolution of Chinese corporate bond yields (Graph.6).

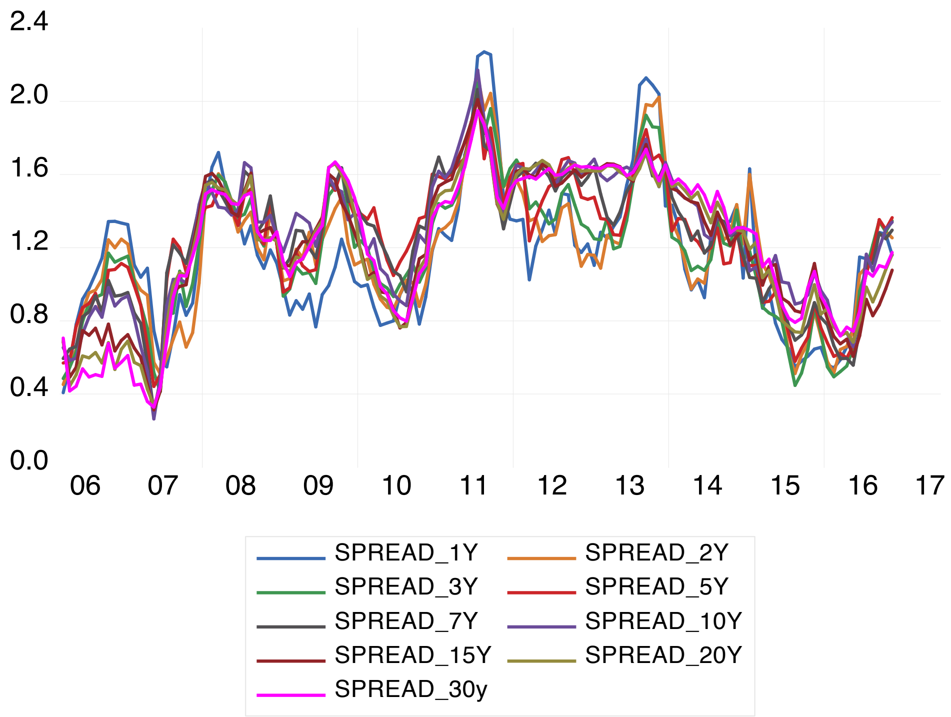
Graph.6 – Evolution of Chinese corporate bond yields



This chart is almost similar to that of Chinese government bonds. Yields are obviously higher given the greater risk investors face by investing in these bonds rather than treasury bonds. Interestingly, the dispersion in chart number 2 is much higher than in chart 1 with higher greater increase in periods of growth and lower lows in negative periods. It is certainly much more interesting, however, to go and see the trend of the spread between these two types of bonds.

Below is the chart corresponding to China's yield differentials: corporate yields minus Treasury yields (Graph.7).

Graph.7 – China's yield differentials (corporate bonds minus treasury bonds)



As can be seen from the chart above, the spread has a decidedly increasing trend. This is indicative of the fact that corporate bonds are growing faster than Chinese government bonds. The most significant positive peaks are found between 2006 and 2007, at the beginning of 2008, at the beginning of 2011, at the beginning of 2013 and at the end of 2016. The negative ones, on the other hand, we find them at the end of 2006, at the beginning of 2010 and between 2015 and 2016.

In addition, from the chart number 3 we can clearly distinguish a trend that differs from that of the other spreads. This is the trend of the Spread_1y. This anomalous movement in the aforementioned series stems from the fact that corporate bonds with a maturity of one year have much wider fluctuations than other corporate bonds with different maturities.

4. Methodology

4.1 Calculation of the yield curve parameters

To calculate the three parameters, I used the same method used by Eric Girardin (for the proxies) in the paper "Price discovery in china's corporate and treasury yield curves" (Girardin, Lunven and Chen, 2021). For the first parameter called levels (beta0) I used the longest maturity bond yield (30 years) for both the corporate yield curve and the treasury yield curve.

To calculate the slope factor (beta1) I used the spread between the longest maturity returns, the 30-year ones, and the shorter-term returns, 1 year. I used the same process again for both the corporate yield curve and the treasury yield curve.

For the third parameter (curvatures) it was calculated as twice the three-year yield minus both one-year and 30-year returns: [(2*y3year)-y1year-y 30year] and [(2*x3year) -(x1year) -(x30year)], respectively for the Treasury (y) and the corporate bond market (x).

4.2 ARDL Method

I used ARDL regression to see the ARDL Long Run Form, Bounds Test and the ECM.

ARDL models are linear time series models in which both dependent and independent variables are correlated not only simultaneously, but also through historical (delayed) values. In particular, if y_t is the dependent variable and $x_1, \dots, x_k$ are k explanatory variables, a general ARDL model $(p, q_1, \dots, q_k)$ is given by: $y_t = a_0 + a_1 t + \sum_{i=1}^{p} \psi_i y_{t-i} + \sum_{j=1}^{k} \sum_{l_j=0}^{q_j} \beta_{j,l_j} x_{j,t-l_j} + \epsilon_t$

Where ϵ_t are the usual innovations, a_0 is a constant term, and a_1, ψ_i , and β_{j,l_j} are respectively the coefficients associated with a linear trend, the delays of y_t , and the delays of the k regressors $x_{j,t}$ for $j = 1, \dots, k$. Alternatively, with L we indicate the usual delay operator and define $\psi(L)$ and $\beta_j(L)$ as the delay polynomials:

$\psi(L) = 1 - \sum_{i=1}^{p} \psi_i L^i$ and $\beta_j(L) = 1 - \sum_{l_j=1}^{q_j} \beta_{j,l_j} L^{l_j}$

The above equation can then be rewritten as: $\psi(L) y_t = a_0 + a_1 t + \sum_{j=1}^{k} \beta_j(L) x_{j,t} + \epsilon_t$

A dynamic error correction model (ECM) can be derived from ARDL through a simple linear transformation. Likewise, the ECM integrates the short-run dynamics with the long-run equilibrium without losing long-run information and avoids problems such as spurious relationship resulting from non-stationary time series data.

To illustrate the ARDL modeling approach, the following simple model can be considered: $y_t = \alpha + \beta x_t + \delta z_t + e_t$

The error correction version of the ARDL model is given by:

$$\Delta y_t = \alpha_0 + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \sum_{i=1}^{p} \delta_i \Delta x_{t-i} + \sum_{i=1}^{p} \varepsilon_i \Delta z_{t-i} + \lambda_1 y_{t-1} + \lambda_2 x_{t-1} + \lambda_3 z_{t-1} + u_t$$

The first part of the equation with Beta, Delta and ε represents short run dynamics of the model. The second part with Gammas represents long run relationship. The null hypothesis in the equation is $\lambda_1 + \lambda_2 + \lambda_3 = 0$, which means non-existence of long run relationship[4].

I applied this procedure for all the parameters taken in combinations of two and for all the combinations I repeated the procedure for two distinct samples: 03/01/2006-06/29/2009 and 06/30/2009-05/10/2017.

These two samples were found through the equation estimated by the BREAKLS (least square with breakpoint) method using the variables obtained through the ARDL regressions. I decided to keep the same two samples for all the variables so that I could verify the pre-crisis and post-crisis context. I report the BREAKLS in the appendix.

ARDL bounds testing approach is a cointegration method developed by Pesaran et al. (2001) to test presence of the long run relationship between the variables. This procedure has many advantages over the classical cointegration tests. Firstly, the approach is used irrespective of whether the series are I(0) or I(1). Secondly, unrestricted error correction model (UECM) can be derived from the ARDL bounds testing through a simple linear transformation. This model has both short and long run dynamics. Thirdly,

[4] See Min B. Shrestha, Guna R. Bhatta (2017).

the empirical results show that the approach is superior and provides consistent results for small sample[5].

Bounds test tells us that there is a long-term relationship between the endogenous variable and the exogenous variables if the value of F-statistic is greater than I(1) at 5% significance, if it were to be less than I(1) and I(0) then there is no long-term relationship and finally if the value were to be between I(0) and I(1) the test would be inconclusive. If there is this relationship it means that the variables are cointegrated.

The Variable Cointeq(-1) is the ECM form. We expect the value of the coefficient to be negative and between 0 and 1 and the variable to be significant (Prob. < 5%). If so, then we could read the coefficient of this variable as the rate of adjustment towards the long run equilibrium.

In the following table (table.1) I show one of the tests carried out in order to find the reasoning made previously.

Table.1- Beta0_corp and Beta0_gov ARDL form

Dependent Variable: BETA0_CORP				
Method: ARDL				
Sample (adjusted): 3/29/2006 6/24/2009				
Included observations: 165 after adjustments				
Maximum dependent lags: 4 (Automatic selection)				
Model selection method: Akaike info criterion (AIC)				
Dynamic regressors (4 lags, automatic): BETA0_GOV				
Fixed regressors: C				
Number of models evaluated: 20				
Selected Model: ARDL(4, 4)				
Variable	Coefficient	Std, Error	t-Statistic	Prob,*
BETA0_CORP(-1)	1,141853	0,079168	14,42308	0
BETA0_CORP(-2)	-0,393127	0,119651	-3,28562	0,0013
BETA0_CORP(-3)	0,043198	0,116057	0,372211	0,7102

[5] See Murat Çetin, Eyyup Ecevit, Fahri Seker, Davuthan Günaydin (2015).

BETA0_CORP(-4)	0,169577	0,072314	2,34500	0,0203
BETA0_GOV	0,743747	0,06933	10,727610	0
BETA0_GOV(-1)	-0,514493	0,133014	-3,867974	0,0002
BETA0_GOV(-2)	-0,18676	0,141124	-1,323372	0,1877
BETA0_GOV(-3)	0,280447	0,141426	1,982999	0,0491
BETA0_GOV(-4)	-0,237217	0,09477	-2,503085	0,0133
C	-0,157053	0,040594	-3,868845	0,0002
R-squared	0,995385	Mean dependent var		5,052831
Adjusted R-squared	0,995117	S,D, dependent var		0,761807
S,E, of regression	0,053235	Akaike info criterion		-2,969493
Sum squared resid	0,439272	Schwarz criterion		-2,781254
Log likelihood	254,9832	Hannan-Quinn criter,		-2,893081
F-statistic	3.714,335	Durbin-Watson stat		1,640796
Prob(F-statistic)	0			

Table.2- Beta0_corp and Beta0_gov Bounds test and long-term coefficients

Levels Equation				
Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std, Error	t-Statistic	Prob,
BETA0_GOV	2,226560	0,350936	6,344634	0
C	-4,079246	1,440498	-2,831829	0,0052

EC = BETA0_CORP - (2,2266*BETA0_GOV - 4,0792)

F-Bounds Test		Null Hypothesis: No levels relationship		

Test Statistic	Value	Signif,	I(0)	I(1)

			Asymptotic: n=1000	
F-statistic	6,392734	10%	3,02	3,51
k	1	5%	3,62	4,16
		2,50%	4,18	4,79
		1%	4,94	5,58

Actual Sample Size	165		Finite Sample: n=80	
		10%	3.113	3,61
		5%	3,74	4.303
		1%	5.157	5.917

Table.3- Beta0_corp and Beta0_gov ECM

ARDL Error Correction Regression				
Dependent Variable: D(BETA0_CORP)				
Selected Model: ARDL(4, 4)				
Case 2: Restricted Constant and No Trend				
Sample: 3/01/2006 6/24/2009				
Included observations: 165				
ECM Regression				
Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std, Error	t-Statistic	Prob,
D(BETA0_CORP(-1))	0,180353	0,076303	2,363651	0,0193
D(BETA0_CORP(-2))	-0,212774	0,074712	-2,847921	0,005
D(BETA0_CORP(-3))	-0,169577	0,071763	-2,363024	0,0194
D(BETA0_GOV)	0,743747	0,068231	10,900370	0
D(BETA0_GOV(-1))	0,14353	0,09275	1,547494	0,1238
D(BETA0_GOV(-2))	-0,04323	0,089885	-0,48095	0,6312

D(BETA0_GOV(-3))	0,237217	0,093851	2,527601	0,0125
CointEq(-1)*	-0,0385	0,008735	-4,407455	0

R-squared	0,639099	Mean dependent var		0,005238
Adjusted R-squared	0,623008	S,D, dependent var		0,086149
S,E, of regression	0,052895	Akaike info criterion		-2,993736
Sum squared resid	0,439272	Schwarz criterion		-2,843145
Log likelihood	254,9832	Hannan-Quinn criter,		-2,932606
Durbin-Watson stat	1,640796			

As we can see from table.1, table.2 and table.3 Beta0_corp and Beta0_gov are cointegrated variables since the value of F-statistics is higher than the confidence level of 5% in I(1) and Cointeq(-1) is significant and its coefficient is between 0 and -1. Having coefficient very close to zero we understand that the rate of adjustment from the short period to the long term is very low.

5. Results

In the following sections, I initially presented the estimation of the three fundamental parameters (5.1 Parameter estimation). In this subsection, I indicated how I estimated the parameters and how I graphically represented them. In addition, I explain the results achieved with this quote.

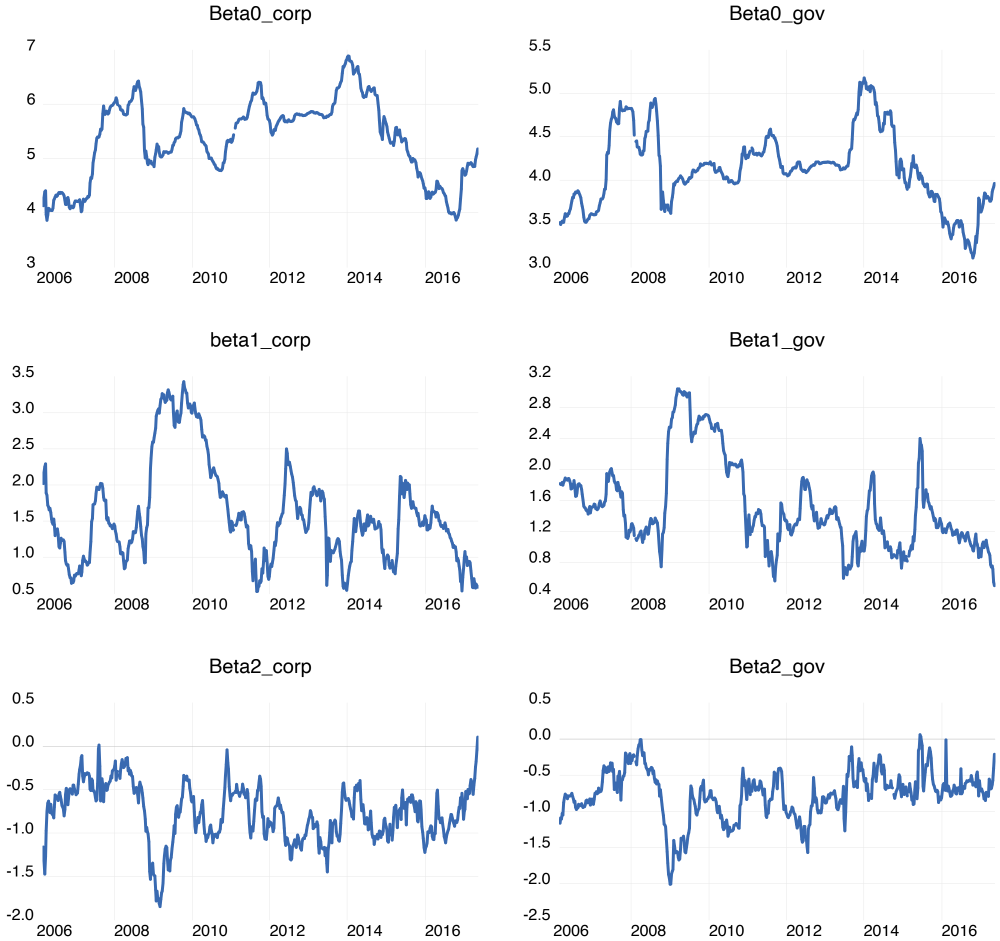
In the second subsection (5.2 Long Term Coefficients) I present the long-term coefficients and the ECM's obtained through the ARDL method explained above. This subsection provides you with the results obtained and an explanation.

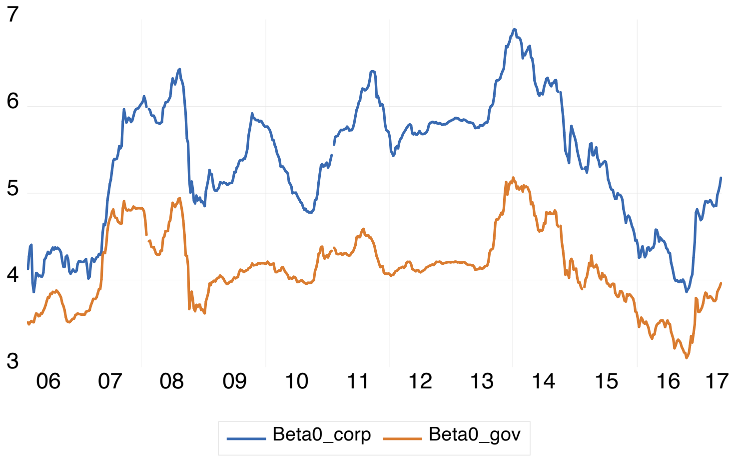
5.1 Parameters estimation

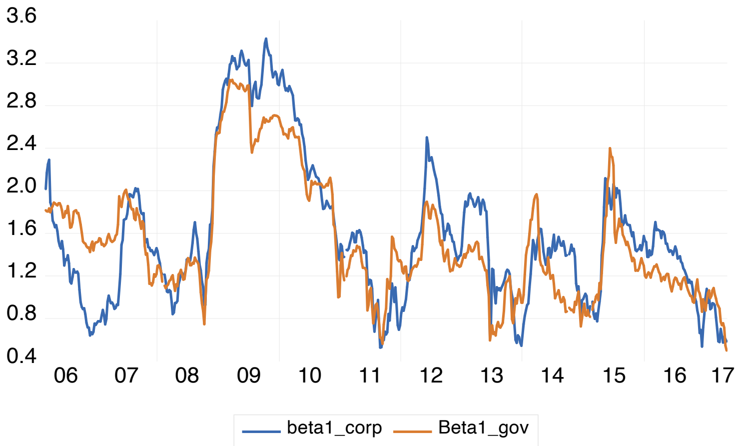
The construction of the 3 fundamental parameters is described in the first part of Methodology (4.1 calculation of the yield curve parameters)

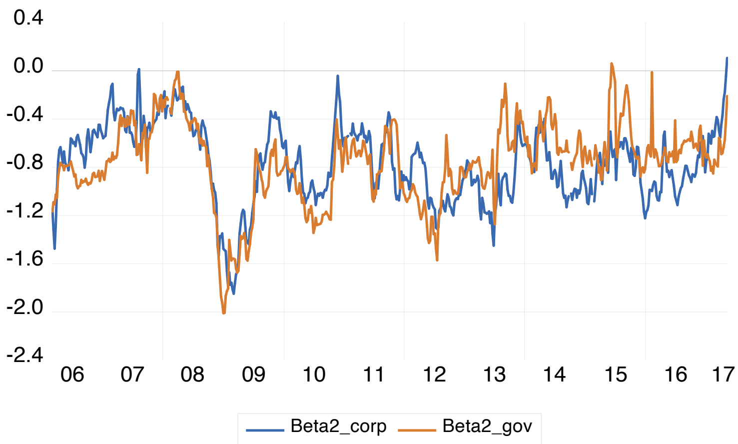
Below in Figure 1 (Fig.1) the graphic representation of these parameters.

Fig.1 – Bond yield curve parameters




7
6
5
4
3
06 07 08 09 10 11 12 13 14 15 16 17
Beta0_corp
Beta0_gov


3.6
3.2
2.8
2.4
2.0
1.6
1.2
0.8
0.4
06 07 08 09 10 11 12 13 14 15 16 17
beta1_corp
Beta1_gov


0.4
0.0
-0.4
-0.8
-1.2
-1.6
-2.0
-2.4
06 07 08 09 10 11 12 13 14 15 16 17
Beta2_corp
Beta2_gov

All six processes are stationary at prime differences, but this is also evident from the graphs. Beta0_corp and Beta0_gov have a slightly growing trend such as Beta2_corp and Beta2_gov, while Beta1_gov and Beta1_corp have a slight decreasing trend.
Tests on the stationarity of variables are available in the appendix.

The slope of the Treasury yield curve is the difference between the longest maturity returns, the 30-year ones, and the shorter-term returns; and every time the curve reverses, there are questions about the reliability of the signal. For example, the fact that yields have remained low for an extended period can change the information provided by the yield curve. In addition, central banks hold a significant share of the long-term bonds in circulation, which affects the "long end" of the yield curve.

The Beta0 parameter (levels) is instead represented by the yield curve with a longer maturity (30 years), so it gives us the average return of the yield curve.

Curvature is the relationship between short-, intermediate-, and long-term yields-to-maturity. Increasing (decreasing) curvature can happen in 2 ways:

1. Short end rates and long end rates go down (up), while the middle range remains constant
2. Short and long end rates remain constant, but the middle range goes up (down).

the curvature indicates, therefore, whether the rate of change of interest rates should decrease or increase in the long run compared to the medium term.

Between 2006 and 2008 both Beta0_corp and Beta0_gov grew a lot, this was due to the pre-great financial crisis situation that had greatly inflated the markets. Between 2008 and 2009, in fact, we can see how the great financial crisis broke out, both parameters fell by about 30%. After this trough, the trend continues to grow for both parameters with a certain constancy until 2014. From 2014 to 2016 we observe a big decrease, so big that the historical lows are reached. In the seventh graph we can see how the trend of Beta0_corp and Beta0_gov is about the same, they maintain about the distance of one percentage point for the entire sample of data used. However, there are times when the value of the two parameters is very close, namely: early 2007, early 2008 and late 2016. As for Beta1_corp and Beta1_gov we note how their trend is very similar. Their trend is slightly decreasing, and we can see that there is only one significantly high peak after the great financial crisis (after 2008). This leads to the idea that investors have no longer believed in the liquidity of short-term bonds, keeping their judgment on bonds with very long maturities constant.

The trend of Beta2_corp and Beta2_gov, on the other hand, is slightly positive. Eliminating the queues of the two series represented in the figure, the trend seems almost constant for Beta2_corp, while for Beta2_gov the positive trend is more visible from the graph. The only relevant peaks from both charts are a trough in 2009 and a positive peak at the end of 2016.

After carrying out this type of analysis directly from the available data we can delve into the technical methodology used for a more precise study of the data just shown.

5.2 Long-term coefficients

The following tables (TABLES.1) shows the long-term coefficients and the ECM's obtained in the first sample taken into account.

TAB.1- long-term coefficients sample and ECM's - 03/01/2006 06/29/2009

SAMPLE 03/01/2006 06/29/2009					
DEPENDENT VARIABLE	REGRESSOR	COEFFICIENT	T-STATISTICS	PROBABILITY	INTERCEPTS
BETA0_CORP	BETA0_GOV	2,226560	6,344634	0.0000	-4,079246
BETA2_CORP	BETA2_GOV	0,863130	8,403102	0.0000	0,021155
BETA0_GOV	BETA0_CORP	0,319200	2,545473	0.0119	2,503165
BETA1_GOV	BETA2_CORP	-1,484487	-5,504446	0.0000	0,809479
BETA2_GOV	BETA2_CORP	0,941294	8,058802	0.0000	-0,177969

ECM SAMPLE 03/01/2006 06/29/2009				
DEPENDENT VARIABLE	REGRESSOR	COEFFICIENT ECM	T-STATISTICS	PROBABILITY
BETA0_CORP	BETA0_GOV	-0,038500	-4,407455	0.0000
BETA2_CORP	BETA2_GOV	-0,149570	-4,053452	0.0001
BETA0_GOV	BETA0_CORP	-0,052086	-3,826239	0.0002
BETA1_GOV	BETA2_CORP	-0,051231	-3,893686	0.0001
BETA2_GOV	BETA2_CORP	-0,124963	-3,805464	0.0002

The beta0_corp and beta0_gov variables are cointegrated. Long-term coefficients show that the long-term impact of a change in beta0_gov on beta0_corp has effects. The variation, in a long-run view, is very close to being equal to two, which means that a unit variation of beta0_gov implies a variation of two units of beta0_corp. If instead we try the inverse regression, we find a long-term coefficient equal to 0.319200 which is very low, so we are led to say that a unit variation of beta0_corp on beta0_gov has a weaker impact than its inverse.

The beta2_corp and beta2_gov variables are also cointegrated. Their long-term coefficients show that, however, the long-term impact of a beta2_gov change on beta2_corp has essentially no effects, contrary to what has been seen for beta0_gov and beta0_corp. The long-run variation is very close to being equal to the initial variation (the coefficient is close to one, i.e. 0.863130). If instead we try the inverse regression, we find a long-term coefficient equal to 0.941294 so always very close to one.

Finally, in TAB.1 we can also observe that the variables beta1_gov and beta2_corp are cointegrated. Long-term coefficients show that the long-term impact of a change in beta2_corp on beta1_gov has effects, as for beta0_gov and beta0_corp. The long-run variation has a coefficient of -1.484487 which means that a unit change of beta2_corp implies a negative change of about 1.5 units of beta1_gov.

Regarding the ECM's we could read the coefficient of this variable as the rate of adjustment towards the equilibrium long run. All variables have a very small coefficient (almost zero). As a result, the adjustment speed is very low.

The following tables (TABLES.2) shows the long-term coefficients and the ECM's obtained in the second sample taken into consideration.

TAB.2- long-term coefficients sample and ECM's - 06/30/2009 05/10/2017

SAMPLE 06/30/2009 05/10/2017					
DEPENDENT VARIABLE	REGRESSOR	COEFFICIENT	T-STATISTICS	PROBABILITY	INTERCEPTS
BETA1_CORP	BETA1_GOV	1,135766	9,993938	0,000000	-0,091342
BETA2_CORP	BETA0_GOV	-0,031754	-0,203412	0,838900	-0,651749
BETA2_CORP	BETA1_GOV	0,014740	0,138051	0,890300	-0,809572
BETA2_CORP	BETA2_GOV	0,243229	1,196773	0,232100	-0,599878
BETA1_GOV	BETA1_CORP	0,676836	8,436400	0,000000	0,339552
BETA2_GOV	BETA0_CORP	-0,005039	-0,055342	0,955900	-0,701928
BETA2_GOV	BETA1_CORP	-0,116454	-1,396207	0,163400	-0,551805
BETA2_GOV	BETA2_CORP	0,454394	1,841219	0,066300	-0,373617

ECM				
SAMPLE 06/30/2009 05/10/2017				
DEPENDENT VARIABLE	REGRESSOR	COEFFICIENT ECM	T-STATISTICS	PROBABILITY
BETA1_CORP	BETA1_GOV	-0,067080	-4,527843	0.0000
BETA2_CORP	BETA0_GOV	-0,066801	-3,800256	0.0002
BETA2_CORP	BETA1_GOV	-0,072460	-3,867421	0.0001
BETA2_CORP	BETA2_GOV	-0,078138	-4,148031	0.0000
BETA1_GOV	BETA1_CORP	-0,076154	-4,461633	0.0000
BETA2_GOV	BETA0_CORP	-0,091573	-4,266441	0.0000
BETA2_GOV	BETA1_CORP	-0,101018	-4,418649	0.0000
BETA2_GOV	BETA2_CORP	-0,097851	-4,214190	0.0000

Unlike what was obtained in the first sample, the variables beta1_corp and beta1_gov are cointegrated. Their long-run coefficients show that the long-term impact of a change in beta1_gov on beta1_corp essentially has no

effects. The long-run variation is very close to being equal to the initial variation (the coefficient is close to one, i.e. 1.135766). If instead we try the inverse regression, we find a long-term coefficient equal to 0.676836 so not so close to one as the inverse.
The beta2_corp and beta0_gov variables are also cointegrated. Long-term coefficients show that the long-term impact of a change in beta0_gov on beta2_corp is very low and negative, unlike what we saw for beta1_corp and beta1_gov. The long-term variation is very low (the coefficient is close to zero, that is, -0.031754).
The variables beta2_corp and beta1_gov are also cointegrated. Long-term coefficients show that the long-term impact of a change in beta1_gov on beta2_corp is very low and positive, similar to what we have seen for beta2_corp and beta0_gov. The long-term variation is very low (the coefficient is close to zero, that is, 0.014740).
As we had seen in the results of the first sample also in the second sample the variables beta2_corp and beta2_gov are cointegrated. Their long-run coefficients show that the long-term impact of a beta2_gov change on beta2_corp is very low and positive, just as for the variables beta2_corp and beta1_gov. The long-term variation is very low tending to zero (the coefficient is close to zero, i.e. 0.243229). If instead we try the inverse regression, we find a long-term coefficient equal to 0.454394 so not as close to zero as the inverse.
The same reasoning made for the beta2_corp and beta0_gov variables is also valid for beta2_gov-beta0_corp and beta2_gov-beta1_corp (very low and negative long-term coefficients).

Regarding the ECM's we could read the coefficient of this variable as the rate of adjustment towards the equilibrium long run. All variables have a very small coefficient (almost zero). This means that the adjustment speed is very small, as for the first sample.

The only two variables that are cointegrated in both samples are beta2_corp and beta2_gov, this means that the impact of the crisis period has not eliminated their relationship which however decreases as is evident from the long-term coefficients. This is not very significant to our studies as shocks on the third factor, called curvatures, lead to changes in the middle of the yield curve. This factor usually explains about 5% of the yield curve.

The most significant relationships are those that include the levels of the yield curves as any change in it leads to parallel shifts in the term.

structure of the interest rate, in the sense that it brings a shift in the interest rate for any maturity. The level factor explains about 80% of the total variation of the yield curve.

In the first sample we see how both level factors (beta0_corp and beta0_gov) are cointegrated. Beta0_gov greatly affects the performance of beta0_corp having a long-term coefficient close to the value 2. This is the most important result found. Such a significant long-term relationship was however expected as generally an increase or decrease in Treasury bonds normally leads to an increase or decrease in corporate bonds. This is because for investors it would not make sense to buy a risky bond that makes the same amount as a risk-free bond or in any case that does not fully repay the risk taken. Beta0_corp has a very low long-term coefficient, close to 0. This surprises us because if the effect it has beta0_gov on beta0_corp was expected its inverse was not.

In the second sample the two variables are not co-integrated, this is probably due to the stability of post-financial crisis returns.

6. Conclusion

In the last fifteen years in China there has been a very strong development of corporate bonds, but also in all other emerging states. Suffice it to say that it is a very young sector and has already become one of the largest bond markets in the world. This is probably also due to the recent liberalization of the entire Chinese financial system.

In this paper I aimed to bring out the three fundamental parameters (levels, slope and curvature) for both yield curves, both corporate and treasury. Through these three parameters then be able to give an interpretation of prices, obviously taking into account the breakpoint in the period from March 2006 to May 2017. The data used have a weekly frequency.

My intent was to fill a gap in the literature about price discovery between the yield curves of Chinese treasuries and corporate bonds. The three parameters I found were useful to establish that Treasuries, in the entire period viewed, do not have a significant impact on the performance of Chinese corporate bonds. Only the curvature factor has an impact that is not relevant to our studies.

If we focus, however, only in the first period of analysis (03/01/2006-06/29/2009) I found a significant result as it would seem that Treasuries significantly affect corporate bonds. In fact, the first parameter of the yield curve of Chinese government bonds greatly affects the performance of the first parameter of the yield curve of Chinese corporate bonds having a long-term coefficient close to the value 2.

This relationship is not confirmed, however, by the second period analyzed, so it would not have a relevant meaning to generalize this result to the totality of the performance curves taken into account in this work.

A possible idea of future research could be to check which are the elements that most affect the yield curves of Chinese treasuries and corporate bonds. This analysis can be done starting from an in-depth study of interest rates on bank loans or from liquidity risk or the effect of monetary policy changes could be studied. The literature is still very poor, so the possibilities of carrying out new and useful studies for research are many.

Appendix

-Breakpoint test (BREAKLS)

The table below (TAB.3) refers to the breakpoint test carried out to determine the samples used in this search.

TAB.3- BREAKLS, breakpoint test

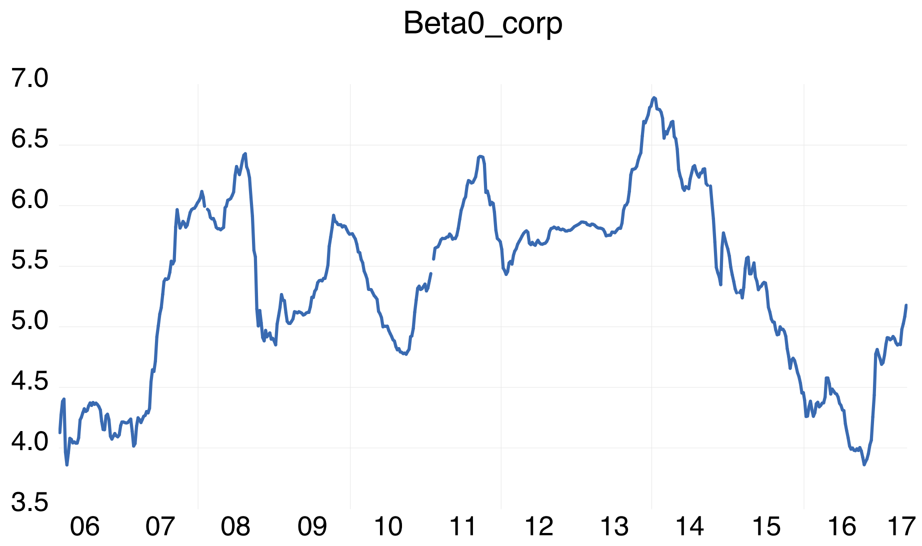
Dependent Variable: B0CORP
Method: Least Squares with Breaks
Date: 05/13/22 Time: 17:29
Sample (adjusted): 3/17/2006 5/12/2017
Included observations: 583 after adjustments
Break type: Bai-Perron tests of L+1 vs. L sequentially determined breaks
Break: 7/03/2009
Selection: Trimming 0.15, Max. breaks 5, Sig. level 0.05
Variable Coefficient Std. Error t-Statistic Prob.
3/17/2006 - 6/26/2009 -- 172 obs
C -0.197093 0.044959 -4.383860 0.0000
B0CORP(-1) 1.040338 0.048914 21.26874 0.0000
B0CORP(-2) -0.092648 0.045194 -2.050013 0.0408
B0GOV 0.755853 0.059755 12.64921 0.0000
B0GOV(-1) -0.646423 0.063867 -10.12147 0.0000
7/03/2009 - 5/12/2017 -- 411 obs
C -0.021507 0.029280 -0.734547 0.4629
B0CORP(-1) 1.321737 0.048075 27.49344 0.0000

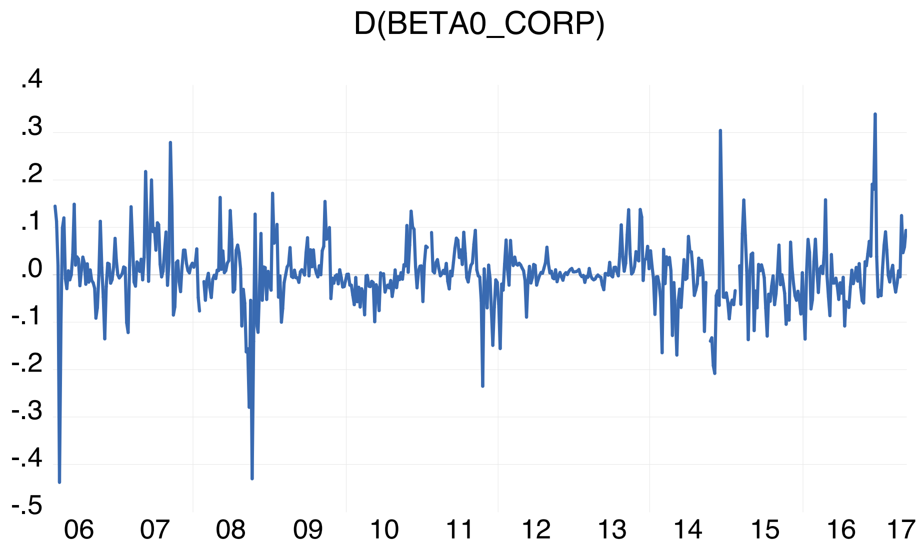
B0CORP(-2) -0.341437 0.046573 -7.331304 0.0000
B0GOV 0.586148 0.052461 11.17295 0.0000
B0GOV(-1) -0.555482 0.053688 -10.34641 0.0000
R-squared 0.994698   Mean dependent var 5.467831
Adjusted R-squared 0.994614   S.D. dependent var 0.719763
S.E. of regression 0.052821   Akaike info criterion -3.026816
Sum squared resid 1.598697   Schwarz criterion -2.951890
Log likelihood 892.3169   Hannan-Quinn criter. -2.997612
F-statistic 11943.70   Durbin-Watson stat 1.963658
Prob(F-statistic) 0.000000

-Stationarity of beta0, beta1, beta2

Inside the appendix for simplicity, I report the analysis of the only variable Beta0_corp, after this there will be two tables that summarize the results.

Fig.2 –Beta0_corp analysis





Analyzing beta0_corp (Fig.2) at the levels we can see that this is not a stationary series, while differentiating it we get a stationary series, D(beta0_corp). This is confirmed by the correlogram of the differentiated series below (Fig.3). Both correlation and autocorrelation decrease very rapidly, falling into almost all cases within the Bartlet bands.

Fig.3 – Correlogramma D(beta0_corp)

Correlogram of D(BETA0_CORP)						
Sample (adjusted): 3/08/2006 5/10/2017						
Included observations: 576 after adjustments						
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|*** |	.|*** |	1	0.426	0.426	105.14	0.000
.|* |	.|. |	2	0.136	-0.055	115.91	0.000
.|* |	.|* |	3	0.126	0.109	125.20	0.000
.|* |	.|* |	4	0.161	0.088	140.24	0.000
.|* |	.|. |	5	0.128	0.026	149.72	0.000
.|. |	.|. |	6	0.049	-0.029	151.11	0.000
.|* |	.|. |	7	0.081	0.071	154.92	0.000
.|. |	.|. |	8	0.049	-0.037	156.34	0.000
.|. |	.|. |	9	0.052	0.037	157.91	0.000
.|. |	.|. |	10	0.045	0.004	159.12	0.000
.|. |	.|. |	11	0.056	0.029	160.95	0.000
.|* |	.|. |	12	0.094	0.060	166.19	0.000
.|. |	.|. |	13	0.070	0.003	169.08	0.000
.|. |	*|. |	14	-0.022	-0.086	169.38	0.000
.|. |	.|. |	15	-0.053	-0.030	171.06	0.000
.|. |	.|. |	16	-0.057	-0.055	172.97	0.000
.|. |	.|. |	17	-0.044	-0.015	174.14	0.000
*|. |	.|. |	18	-0.069	-0.043	176.95	0.000
*|. |	*|. |	19	-0.117	-0.074	185.10	0.000
.|. |	.|. |	20	-0.035	0.067	185.82	0.000
.|. |	.|. |	21	-0.001	0.009	185.82	0.000
.|. |	.|. |	22	0.008	0.027	185.86	0.000
.|. |	.|. |	23	0.016	0.035	186.01	0.000
.|. |	.|. |	24	0.022	0.010	186.30	0.000
.|. |	.|. |	25	0.020	0.000	186.54	0.000
.|. |	.|. |	26	0.039	0.059	187.48	0.000
.|. |	.|. |	27	-0.008	-0.055	187.52	0.000
.|. |	.|. |	28	-0.029	-0.001	188.04	0.000
.|. |	.|. |	29	-0.014	0.001	188.15	0.000
.|. |	.|. |	30	0.006	0.006	188.17	0.000
.|. |	.|. |	31	-0.001	0.001	188.17	0.000

.|. |	.|. |	32	-0.009	-0.003	188.22	0.000
.|. |	.|. |	33	-0.017	-0.048	188.40	0.000
.|. |	.|. |	34	0.023	0.045	188.72	0.000
.|. |	.|. |	35	0.048	0.010	190.11	0.000
.|. |	.|. |	36	0.059	0.037	192.23	0.000

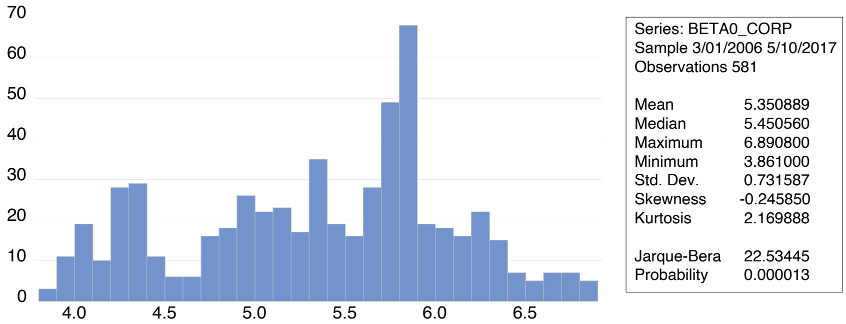
To remove any doubt, we use the ADF test (augmented Dickey-Fuller), which confirms the stationarity of the differentiated process. The ADF test is represented by Fig.4

Fig.4 – Test ADF per D(beta0_corp)

Null Hypothesis: D(BETA0_CORP) has a unit root			
Exogenous: None			
Lag Length: 2 (Automatic - based on SIC, maxlag=18)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.066.307	0.0000
Test critical values:	1% level	-2.569.091	
	5% level	-1.941.389	
	10% level	-1.616.320	

Let's then see the summary statistics (Fig.5).

Fig.5 – Summary statistics of beta0_corp



In addition to the values of mean, median, maximum, minimum and standard deviation we can also evaluate the third and fourth moment of the time series (Skewness-symmetry, Kurtosis). At the bottom we have the Jarque-Bera test, it is a test on the normality of the distribution. The null hypothesis is true when the distribution follows the trend of a Normal distribution, in this case the null hypothesis is rejected so the distribution is not Normal.

In the following table (TAB.4) the results on the parameter stationarity tests. All parameters are stationary at prime differences

TAB.4- Stationarity tests

STATIONARITY		
VARIABLE	stationary at levels	stationary at first difference
BETA0_CORP	No	yes
BETA1_CORP	No	yes
BETA2_CORP	No	yes
BETA0_GOV	No	yes

BETA1_GOV	No	yes
BETA2_GOV	No	yes

TAB.5- Common sample, summary statistics

COMMON SAMPLE						
	BETA0_CORP	BETA0_GOV	BETA1_GOV	BETA1_CORP	BETA2_CORP	BETA2_GOV
Mean	5,35089	4,12804	1,52442	1,58803	-0,77057	-0,764316
Median	5,45056	4,12515	1,36602	1,46000	-0,75964	-0,73492
Maximum	6,89080	5,17900	3,04188	3,43006	0,10528	0,06066
Minimum	3,86100	3,10252	0,49868	0,5255	-1,84832	-2,01048
Std, Dev,	0,731587	0,432986	0,570584	0,688325	0,324204	0,337498
Skewness	-0,24585	0,201585	0,916148	0,904513	-0,367467	-0,643387
Kurtosis	2,16989	2,72119	3,16252	3,21583	3,313626	4,10765
Jarque-Bera	22,53445	5,81688	81,91436	80,35130	15,45679	69,78486
Probability	0,000013	0,054561	0,00000	0,00000	0,00044	0,00000
Sum	3.108,867	2.398,389	885,687	922,645	-447,701	-444,068
Sum Sq, Dev,	3.104,272	108,737	188,829	274,799	60,963	66,065
Observations	581	581	581	581	581	581

In the table above (TAB.5) we have an overview of the summary statistics. The only variable for which we accept the normal test, at a confidence level of 5%, is the variable Beta0_Gov.

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