

Scope Hamburg GmbH

## Rating Validation Study

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ScopeHamburg

# Content

<b>Introduction</b>	<b>1</b>
<b>Rating Distributions and Defaults</b>	<b>2</b>
Initial ratings and rating updates	2
Defaulted rated entities	4
<b>Discriminatory Power, Predictive Power and Historical Robustness</b>	<b>6</b>
Discriminatory power	6
Predictive power	7
Historical robustness	8
<b>Non-systemic Deviations</b>	<b>19</b>
<b>Critical Thresholds</b>	<b>20</b>
<b>Appendices</b>	
Appendix A	Receiver Operator Characteristic
Appendix B	Rating transitions
Appendix C	Cumulative default rates
Appendix D	Average Position

# Introduction

Scope Hamburg GmbH (hereafter “SHG”) publishes this study on defaults, rating transitions and complementary statistics in accordance with Regulation (EC) No 1060/2009 (as amended) and the guidelines on the validation and review of Credit Rating Agencies’ methodologies (ESMA/2016/1575; as amended). The full report complying with these guidelines has been provided to ESMA.

This study allows users of credit ratings assigned by SHG and interested third parties to evaluate the performance and stability of these ratings based on key quantitative assessments and a qualitative discussion of these outcomes. SHG publishes an annual update of this study on a regular basis. In addition, SHG regularly publishes a semi-annual update of the list of defaulted entities.

In order to enhance data coverage, we follow the ESMA guidelines and include in some of our analyses non-regulated/private ratings, which were assigned particularly before 2010. In the following sections, we clearly note whether validation statistics therein were calculated based solely on regulated/public ratings or jointly on regulated/public and non-regulated/private ratings. Ratings can be solicited or unsolicited.

The ratings were assigned to corporates and corporate issuances, corporates structured as project financings (projects) and project finance transactions as well as single-tranche structured finance transactions. We typically refer to corporates and transactions as “entities” in the text and combine different asset classes in our analyses. Corporate issuance ratings and project finance ratings, which refer to expected loss are classified as Limited Quantitative Evidence (LQE) ratings. Their validation, hence, follows the applicable ESMA guidelines and is presented separately. Nevertheless, the corporate or project ratings underlying these expected loss ratings are included in the general validation statistics. If no separate corporate or project rating is available, we use a proxy rating (e.g., the anchor rating of a project finance transaction) or deduct the notching adjustment from the expected loss rating in order to get a pro forma proxy rating. In some instances, we also combine rating categories to Credit Quality Steps (CQS) as defined in the regulations.

As a general remark, this study covers neither credit estimates/pre-analyses nor structured finance ratings as defined in the regulations (securitisations).

# Rating Distributions and Defaults

## Initial ratings and rating updates

In the years 2002 through 2020, SHG assigned a total of 901 public and private ratings, of which 311 were initial ratings and 590 were rating updates (figures 1 and 2). 43 rated entities defaulted during this period.

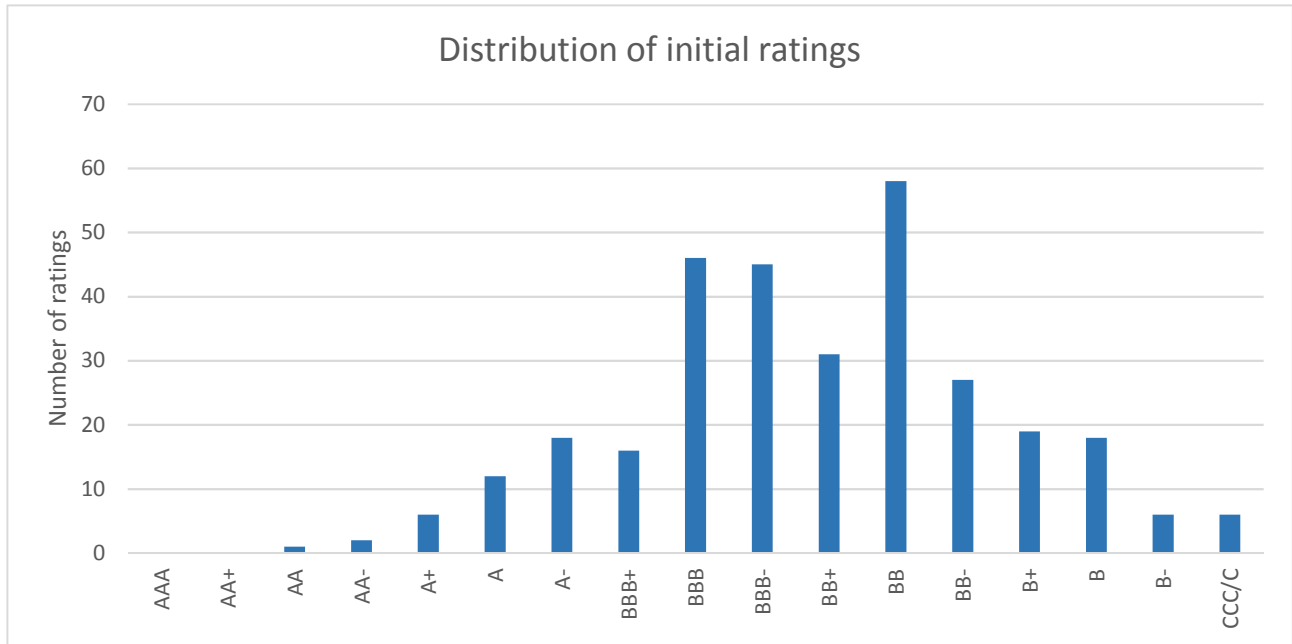


Figure 1: Distribution of initial ratings

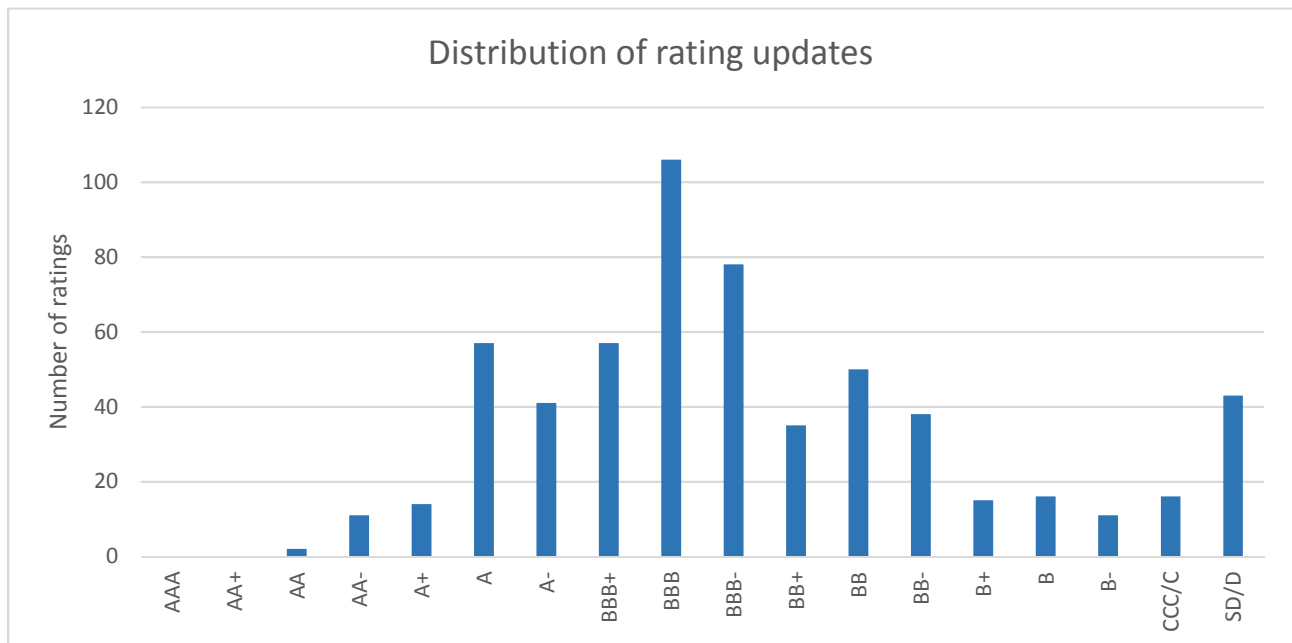


Figure 2: Distribution of rating updates

A total of 540 of all assigned ratings were public ratings (figures 3 and 4). Of these public ratings, 144 were initial ratings and 396 were rating updates. Nine entities, which were assigned a public rating defaulted during the entire period.

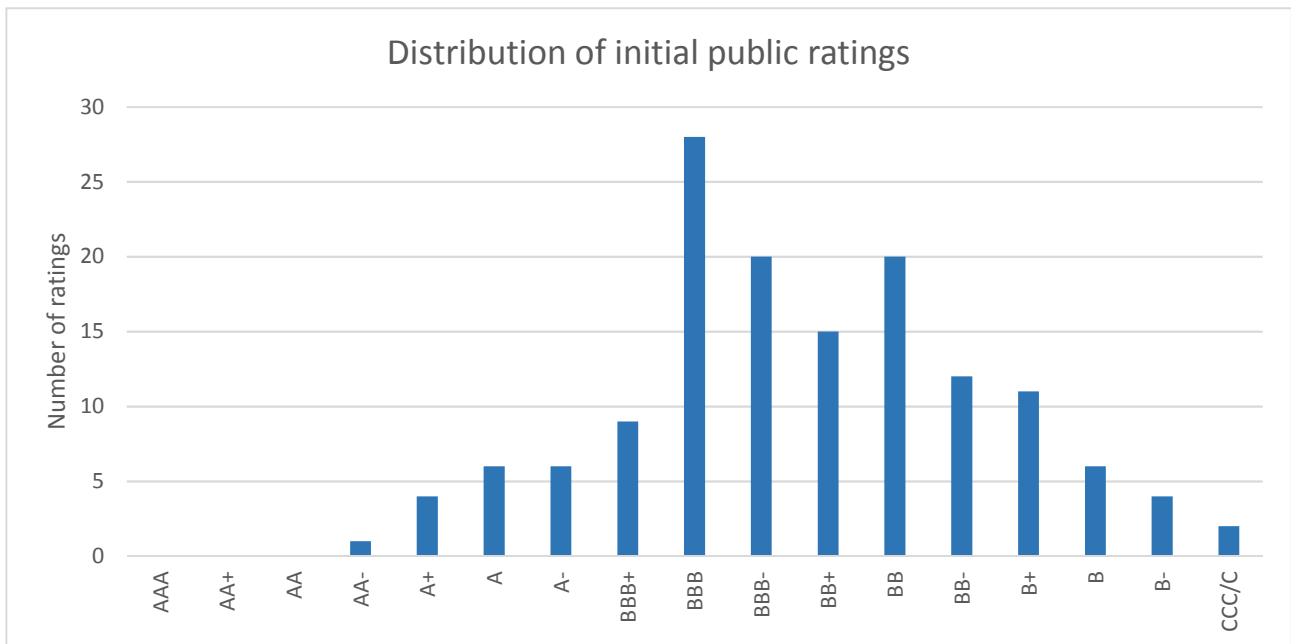


Figure 3: Distribution of initial public ratings

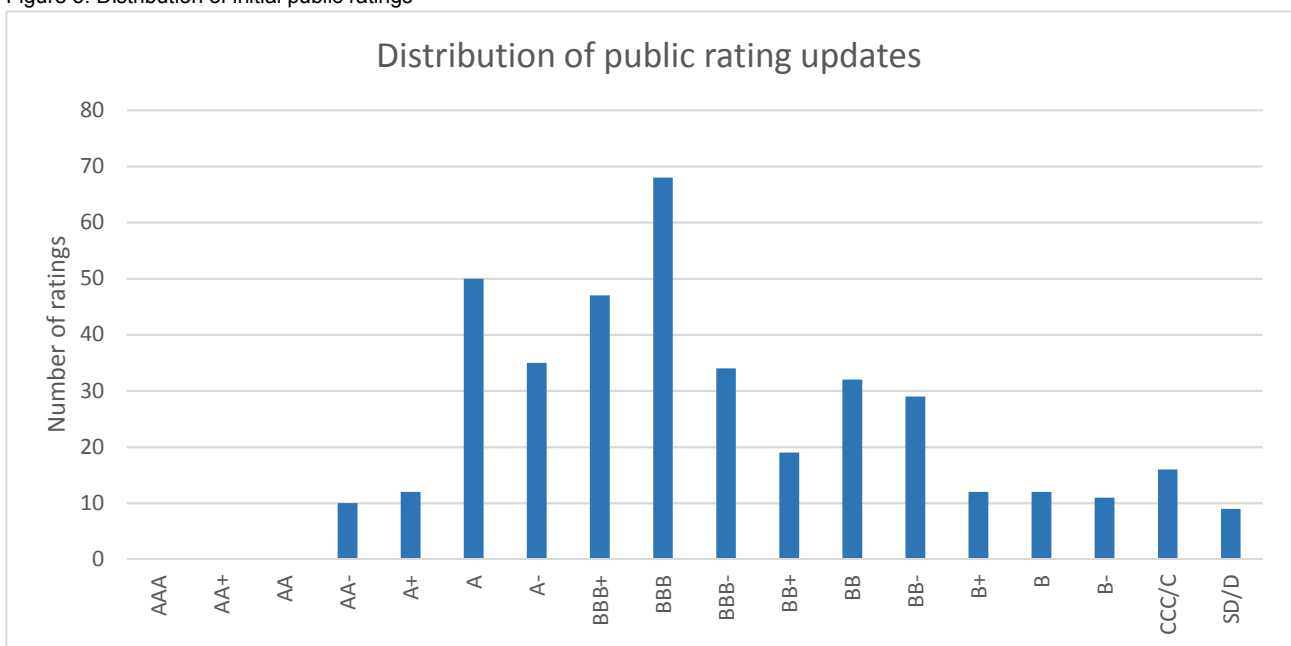


Figure 4: Distribution of public rating updates

Initial ratings were concentrated around the BB rating category, driven by the high number of ratings assigned to small and medium-sized enterprises. Another maximum can be observed around BBB and BBB- rating categories, which typically represent the lower limits for investors to invest in such entities. This was particularly the case for public ratings. The distribution of rating updates tends towards investment grade rating categories because solicited rating updates were typically only requested in case the initial ratings were already investment grade.

## Defaulted rated entities

Between 2002 and 2020, 43 rated entities defaulted of which six entities defaulted within 12 months after the last rating update (table 1). Only four ratings were being monitored at the time of default (public ratings). Of the 33 private ratings, which were assigned prior to default, four ratings were assigned to entities, which were guilty of reporting falsified accounts to the auditors and SHG. The company names of those companies to which a private rating was assigned or whose ratings were accessible only for subscribers cannot be disclosed.

Company	Rating type	Last rating update	Rating date	Regulated rating	Date of default
Company 1	Corporate rating	B	May 03	no	Sep 04
Company 2	Corporate rating	B	February 05	no	Apr 06
Company 3	Corporate rating	BBB-	March 05	no	June 07
Company 4	Corporate rating	B-	February 04	no	February 08
Company 5	Corporate rating	B+	Apr 06	no	Apr 08
Company 6	Corporate rating	BB	Aug 06	no	Aug 08
Company 7	Corporate rating	BB-	Aug 06	no	February 09
Company 8	Corporate rating	BB-	Nov 06	no	Apr 09
Company 9	Corporate rating	BBB-	October 06	no	June 09
Company 10	Corporate rating	BB	Sep 06	yes	Aug 09
Company 11	Corporate rating	B+	Nov 08	no	March 10
Company 12	Corporate rating	BB-	Nov 04	yes	June 10
Company 13	Corporate rating	B-	Apr 05	yes	July 10
Company 14	Corporate rating	BB	June 08	no	October 10
Company 15	Corporate rating	BB	Nov 06	no	February 11
Company 16	Corporate rating	BB	Nov 06	no	February 11
Company 17	Corporate rating	BBB-	Aug 10	no	March 11
Company 18	Corporate rating	BB	Sep 05	no	Apr 11
Company 19	Corporate rating	B	Sep 06	no	October 11
Company 20	Corporate rating	B	June 07	no	October 11
Company 21	Corporate rating	B+	February 06	no	February 12
Company 22	Corporate rating	BB	July 07	no	July 12
Company 23	Corporate rating	BB	Sep 08	no	December 12
Company 24	Corporate rating	BBB-	December 07	no	February 13
Company 25	Corporate rating	B	October 08	no	February 13
Company 26	Corporate rating	BBB-	Aug 09	no	February 13
Company 27	Corporate rating	BB+	December 08	no	March 13
Company 28	Corporate rating	BB+	July 07	no	July 13
Company 29	Corporate rating	BB	Nov 09	no	Aug 13
Company 30	Corporate rating	BB	July 07	no	January 14
Company 31	Corporate rating	BB	Aug 12	no	February 14
RENA GmbH	Corporate rating	CC	February 14	yes	March 14
Company 33	Corporate rating	BB	February 10	no	January 16
Scholz AG	Corporate rating	C	January 16	yes	May 16
Company 35	Corporate rating	BB-	October 11	no	July 16
Rudolf Wöhr AG	Corporate rating	C	October 16	yes	December 16
Company 37	Corporate rating	B+	May 07	yes	May 17
Company 38	Corporate rating	BB-	June 2014	no	December 17
Company 39	Corporate rating	CC	May 2014	no	July 2019
Company 40	Corporate rating	BBB-	July 2011	no	July 2019
Company 41	Corporate rating	BB+	August 2013	no	June 2020
Joh. Friedrich Behrens AG	Corporate rating	C	November 2020	yes	November 2020
Dr. Wiesent Sozial gGmbH	Corporate rating	CC	August 2020	yes	December 2020

Table 1: Defaulted rated entities

# Discriminatory Power, Predictive Power and Historical Robustness

Please note that all numbers, figures and tables in the following sections exclude events of default that occurred as a result of financial misstatement (e.g., reporting falsified accounts) because such events of default are not related to the performance of rating methodologies.

Throughout this chapter, we classify as LQE ratings all types of ratings whose number of historical ratings does not exceed 100 or where the number of defaults is less than 5. Based on these thresholds, all corporate issuance ratings and project finance ratings, which are based on an expected loss approach fall under this definition. Their validation is therefore presented separately in this chapter.

## Discriminatory power

The discriminatory power of SHG's rating methodologies relates to the ability to rank-order the rated entities given their future status (default; recovery) at predefined time horizons. In order to demonstrate the discriminatory power, several measures and statistics are used to provide deeper insight.

As the applicable statistical measures for analysing the discriminatory power require a relatively large number of data points, we include both, public and private ratings in this analysis.

The discriminatory power of rating methodologies for issuer, project or structured finance ratings (probability of default ratings) is analysed based on the Receiver Operator Characteristic (ROC) in conjunction with the Area under Curve (AUC) for various time horizons (see Appendix A for a technical description). The outcomes suggest a high discriminatory power.

SHG also assigned 138 ratings, which refer to expected loss measures. The discriminatory power of the underlying corporate or project ratings is already captured in the above validation statistics. As neither any of these underlying entities nor the issuances/transactions themselves have defaulted, we cannot perform any additional tests for measuring the discriminatory power of rating methodologies for expected loss-based ratings. Moreover, we rely neither on third-party data nor on hypothetical transactions, since neither data for comparable transactions nor related information are publicly available to a sufficient extent. In case we observe defaults for such ratings, we will collect information, if available, on the realised recovery. Otherwise, we will base the analysis of the discriminatory power on standard recovery levels assumed in the market or presented in relevant studies.

Figure 5 shows the observed default rates across CQS for a one-year time horizon.



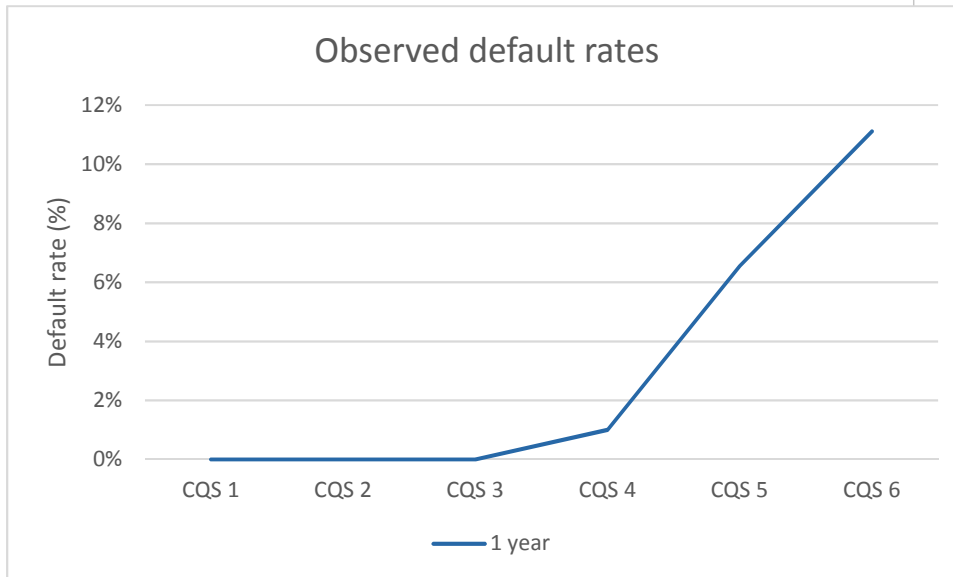


Figure 5: Observed default rates

## Predictive power

Observed default rates are compared to expected default rates. This analysis is based jointly on public and private ratings.

As a means of analysing the predictive power, a two-sided binomial test is performed for every CQS against the hypothesis of observing significantly lower or higher default rates. The results do not indicate that observed default rates are significantly lower or higher than the expected values.

As the number of rated entities is comparatively low, statistical tests, which rely on a large sample and that could support the above findings on predictive power (e.g., chi squared test) are not performed.

SHG also assigned 138 ratings, which refer to expected loss measures. The predictive power of the underlying corporate or project ratings is already captured in the above validation statistics. As neither any of these underlying entities nor the issuances/transactions themselves have defaulted, we cannot perform any additional tests for measuring the predictive power of rating methodologies for expected loss-based ratings. Moreover, we rely neither on third-party data nor on hypothetical transactions, since neither data for comparable transactions nor related information are publicly available to a sufficient extent. In case we observe defaults for such ratings, we will collect information, if available, on the realised recovery and compare this to that recovery assumption applied in the rating process. Otherwise, we will base the analysis of the predictive power on standard recovery levels assumed in the market or presented in relevant studies.

## Historical robustness

Historical robustness of a rating methodology relates to the stability of assigned ratings and the distribution of ratings over time. Transition matrices are presented for several time horizons and separately for initial ratings as well as initial ratings and rating updates. Additionally, upgrade/total and changed/unchanged ratios are calculated.

Tables 2 to 4 present upgrade and downgrade events for public and public/private ratings assigned between 2002 and 2019. The year refers to the year in which the rating was assigned, with an upgrade, downgrade, default or no change event in the subsequent year. Rated entities without a rating in the subsequent year are not covered.

Please note that the validation statistics in this section are presented separately for non-LQE and LQE-ratings. For LQE-ratings, we only show statistics jointly calculated for public and private ratings in order to increase the number of available ratings.

Year	Upgrades	Downgrades	Unchanged	Default	Sum	Upgrade/ Total Ratio <sup>1</sup>	Changed/ Unchanged Ratio <sup>1</sup>
2002	0	0	2	0	2	0.00	0.00
2003	1	2	1	0	4	0.25	3.00
2004	2	0	6	0	8	0.25	0.33
2005	3	0	6	0	9	0.33	0.50
2006	2	2	5	0	9	0.22	0.80
2007	1	2	5	0	8	0.13	0.60
2008	0	1	3	0	4	0.00	0.33
2009	1	0	4	0	5	0.20	0.25
2010	2	0	8	0	10	0.20	0.25
2011	0	3	6	0	9	0.00	0.50
2012	1	4	6	0	11	0.09	0.83
2013	2	1	10	1	14	0.14	0.30
2014	1	2	13	0	16	0.06	0.23
2015	2	0	17	2	21	0.10	0.12
2016	1	0	19	0	20	0.05	0.05
2017	1	2	24	0	27	0.04	0.13
2018	0	5	28	0	33	0.00	0.18
2019	0	4	24	2	30	0.00	0.17
<b>total</b>	<b>20</b>	<b>28</b>	<b>187</b>	<b>5</b>	<b>240</b>	<b>0.08</b>	<b>0.26</b>

Table 2: One-year upgrades and downgrades – public ratings (probability of default-based)

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<sup>1</sup> excluding defaults

Year	Upgrades	Downgrades	Unchanged	Default	Sum	Upgrade/ Total Ratio <sup>2</sup>	Changed/ Unchanged Ratio <sup>2</sup>
2002	0	0	2	0	2	0.00	0.00
2003	2	2	1	1	6	0.33	4.00
2004	4	1	7	0	12	0.33	0.71
2005	3	1	8	1	12	0.25	0.50
2006	2	3	8	0	13	0.15	0.63
2007	2	3	8	0	13	0.15	0.63
2008	1	1	3	0	5	0.20	0.67
2009	2	0	6	0	8	0.25	0.33
2010	8	1	18	0	27	0.30	0.50
2011	5	6	16	0	27	0.19	0.69
2012	3	4	10	0	17	0.18	0.70
2013	2	2	17	1	22	0.09	0.24
2014	1	5	24	0	30	0.03	0.25
2015	2	2	26	2	32	0.06	0.15
2016	1	2	29	0	32	0.03	0.10
2017	1	2	35	0	38	0.03	0.09
2018	0	7	35	0	42	0.00	0.20
2019	0	8	26	2	36	0.00	0.31
<b>total</b>	<b>39</b>	<b>50</b>	<b>279</b>	<b>7</b>	<b>375</b>	<b>0.10</b>	<b>0.32</b>

Table 3: One-year upgrades and downgrades – public and private ratings (probability of default-based)

Year	Upgrades	Downgrades	Unchanged	Default	Sum	Upgrade/ Total Ratio <sup>3</sup>	Changed/ Unchanged Ratio <sup>3</sup>
2011	1	0	0	0	1	1.00	n/a
2012	0	0	0	0	0	n/a	n/a
2013	0	0	0	0	0	n/a	n/a
2014	0	0	0	0	0	n/a	n/a
2015	0	3	7	0	10	0.00	0.43
2016	0	2	12	0	14	0.00	0.17
2017	0	2	13	0	15	0.00	0.15
2018	0	5	13	0	18	0.00	0.38
2019	1	5	8	0	14	0.07	0.75
<b>total</b>	<b>2</b>	<b>17</b>	<b>53</b>	<b>0</b>	<b>72</b>	<b>0.03</b>	<b>0.36</b>

Table 4: One-year upgrades and downgrades – public and private ratings (expected loss-based)

An overall changed/unchanged ratio of 0.26 for public ratings and 0.32 for public and private ratings emphasises the high stability of SHG's ratings. Similar patterns can be observed for expected loss-based ratings.

Tables 5 through 10 show relative and absolute rating transitions of public ratings (probability of default-based) for time horizons ranging from one to three years. Similarly, tables 13 through 24 show relative and absolute rating transitions of public and private ratings (probability of default-based and expected loss-based) for time horizons from one to three years. Please note that relative values refer to actual ratings assigned in the subsequent period. Entities without a rating in the subsequent period (migration to NR) are not considered. As a consequence, relative values for migration to rating categories SD and D do not correspond to default rates. These rating transitions suggest a high degree of rating stability, particularly for investment grade ratings. More information on the calculation of rating transitions is provided in Appendix B.

<sup>2</sup> excluding defaults

<sup>3</sup> excluding defaults

To From	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	CCC/C	SD/D
AAA																		
AA+																		
AA																		
AA-				100%														
A+				10%	90%													
A						97%	3%											
A-						4%	91%	4%										
BBB+							5%	90%	5%									
BBB								2%	88%	10%								
BBB-									7%	73%	20%							
BB+										15%	54%	15%	8%			8%		
BB												68%	16%		4%	4%	4%	4%
BB-											13%	20%	40%	13%	7%			7%
B+													57%	14%			14%	14%
B														20%	40%	20%	20%	
B-														25%		50%		25%
CCC/C																		

Table 5: Rating transitions – public ratings (probability of default-based; relative values) – 1 year

To From	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	CCC/C	SD/D
AAA																		
AA+																		
AA																		
AA-				8														
A+				1	9													
A						37	1											
A-						1	21	1										
BBB+							1	18	1									
BBB								1	46	5								
BBB-									1	11	3							
BB+										2	7	2	1			1		
BB												17	4		1	1	1	1
BB-											2	3	6	2	1			1
B+													4	1			1	1
B														1	2	1	1	
B-														1		2		1
CCC/C																		

Table 6: Rating transitions – public ratings (probability of default-based; absolute values) – 1 year

To From	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	CCC/C	SD/D
AAA																		
AA+																		
AA																		
AA-				100%														
A+				22%	78%													
A						94%	6%											
A-						11%	84%	5%										
BBB+							11%	78%	6%	6%								
BBB								5%	83%	10%	2%							
BBB-								9%	9%	45%	18%	9%	9%					
BB+										13%	25%	25%	13%	13%		13%		
BB												56%			22%	6%		17%
BB-												10%	50%	20%				20%
B+											50%		50%					
B													25%			25%	25%	25%
B-																50%		50%
CCC/C																		100%

Table 7: Rating transitions – public ratings (probability of default-based; relative values) – 2 years

To From	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	CCC/C	SD/D
AAA																		
AA+																		
AA																		
AA-				6														
A+				2	7													
A						33	2											
A-						2	16	1										
BBB+							2	14	1	1								
BBB								2	34	4	1							
BBB-								1	1	5	2	1	1					
BB+										1	2	2	1	1		1		
BB												10			4	1		3
BB-												1	5	2				2
B+											1		1					
B													1			1	1	1
B-																1		1
CCC/C																		1

Table 8: Rating transitions – public ratings (probability of default-based; absolute values) – 2 years

To From	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	CCC/C	SD/D
AAA																		
AA+																		
AA																		
AA-				100%														
A+				43%	57%													
A						90%	7%	3%										
A-						13%	87%											
BBB+							20%	73%	7%									
BBB								3%	71%	18%	3%	3%	3%					
BBB-									14%	29%	29%	29%						
BB+										22%	22%	11%	22%			11%		11%
BB												33%			8%	8%	8%	42%
BB-										11%		22%	11%	11%	11%		11%	22%
B+														100%				
B													33%					67%
B-																		100%
CCC/C																		100%

Table 9: Rating transitions – public ratings (probability of default-based; relative values) – 3 years

To From	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	CCC/C	SD/D
AAA																		
AA+																		
AA																		
AA-				4														
A+				3	4													
A						27	2	1										
A-						2	13											
BBB+							3	11	1									
BBB								1	24	6	1	1	1					
BBB-									1	2	2	2						
BB+										2	2	1	2			1		1
BB												4			1	1	1	5
BB-										1		2	1	1	1		1	2
B+														1				
B													1					2
B-																		1
CCC/C																		1

Table 10: Rating transitions – public ratings (probability of default-based; absolute values) – 3 years

To From	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	CCC/C	SD/D
AAA																		
AA+																		
AA																		
AA-				100%														
A+				8%	92%													
A						98%	2%											
A-						3%	90%	7%										
BBB+							4%	82%	14%									
BBB								3%	85%	10%		1%						
BBB-									14%	71%	13%		2%					
BB+									5%	19%	43%	19%	10%			5%		
BB									2%	7%	2%	64%	14%		2%	2%	2%	2%
BB-											9%	23%	41%	18%	5%			5%
B+													44%	22%	11%		11%	11%
B														11%	44%	11%	11%	22%
B-														25%		50%		25%
CCC/C															33%	33%		33%

Table 11: Rating transitions – public and private ratings (probability of default-based; relative values) – 1 year

To From	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	CCC/C	SD/D
AAA																		
AA+																		
AA																		
AA-				8														
A+				1	12													
A						41	1											
A-						1	27	2										
BBB+							1	23	4									
BBB								3	73	9		1						
BBB-									8	40	7		1					
BB+									1	4	9	4	2			1		
BB									1	3	1	27	6		1	1	1	1
BB-											2	5	9	4	1			1
B+													4	2	1		1	1
B														1	4	1	1	2
B-														1		2		1
CCC/C															1	1		1

Table 12: Rating transitions – public and private ratings (probability of default-based; absolute values) – 1 year

To From	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	CCC/C	SD/D
AAA																		
AA+																		
AA			100%															
AA-				100%														
A+				15%	77%	8%												
A						93%	5%				3%							
A-						7%	74%	15%	4%									
BBB+							9%	74%	9%	9%								
BBB								4%	80%	11%	1%	1%	1%					
BBB-								2%	19%	55%	14%	2%	7%					
BB+								8%		31%	23%	15%	8%	8%		8%		
BB										7%		45%	10%		14%	3%		21%
BB-											7%	7%	40%	27%	7%			13%
B+											20%		20%				20%	40%
B													14%		14%	14%	14%	43%
B-																50%		50%
CCC/C																		100%

Table 13: Rating transitions – public and private ratings (probability of default-based; relative values) – 2 years

To From	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	CCC/C	SD/D
AAA																		
AA+																		
AA			2															
AA-				6														
A+				2	10	1												
A						37	2				1							
A-						2	20	4	1									
BBB+							2	17	2	2								
BBB								3	57	8	1	1	1					
BBB-								1	8	23	6	1	3					
BB+								1		4	3	2	1	1		1		
BB										2		13	3		4	1		6
BB-											1	1	6	4	1			2
B+											1		1				1	2
B													1		1	1	1	3
B-																1		1
CCC/C																		1

Table 14: Rating transitions – public and private ratings (probability of default-based; absolute values) – 2 years



To From	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	CCC/C	SD/D
AAA																		
AA+																		
AA																		
AA-				100%														
A+				33%	67%													
A						89%	6%	3%				3%						
A-						10%	80%	5%	5%									
BBB+							15%	70%	10%	5%								
BBB								4%	71%	16%	2%	5%	2%					
BBB-									28%	39%	22%	6%	3%					3%
BB+								7%		27%	13%	13%	20%			7%		13%
BB									5%	5%		27%	9%		5%	5%	5%	41%
BB-										13%		13%	7%	13%	13%		7%	33%
B+														33%				67%
B													20%					80%
B-																		100%
CCC/C																		100%

Table 15: Rating transitions – public and private ratings (probability of default-based; relative values) – 3 years

To From	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	CCC/C	SD/D
AAA																		
AA+																		
AA																		
AA-				4														
A+				3	6													
A						31	2	1				1						
A-						2	16	1	1									
BBB+							3	14	2	1								
BBB								2	40	9	1	3	1					
BBB-									10	14	8	2	1					1
BB+								1		4	2	2	3			1		2
BB									1	1		6	2		1	1	1	9
BB-										2		2	1	2	2		1	5
B+														1				2
B													1					4
B-																		1
CCC/C																		1

Table 16: Rating transitions – public and private ratings (probability of default-based; absolute values) – 3 years

To From	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	CCC/C	SD/D
AAA																		
AA+																		
AA																		
AA-																		
A+																		
A																		
A-							82%	18%										
BBB+								94%				6%						
BBB						6%		6%	76%	6%					6%			
BBB-										71%	14%	14%						
BB+											50%	17%	33%					
BB												33%	33%	33%				
BB-													50%		33%	17%		
B+														100%				
B																	100%	
B-																100%		
CCC/C																		

Table 17: Rating transitions – public and private ratings (expected loss-based; relative values) – 1 year

To From	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	CCC/C	SD/D
AAA																		
AA+																		
AA																		
AA-																		
A+																		
A																		
A-							9	2										
BBB+								17				1						
BBB						1		1	13	1				1				
BBB-										5	1	1						
BB+											3	1	2					
BB												1	1	1				
BB-													3		2	1		
B+														1				
B																	2	
B-																1		
CCC/C																		

Table 18: Rating transitions – public and private ratings (expected loss-based; absolute values) – 1 year

To From	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	CCC/C	SD/D
AAA																		
AA+																		
AA																		
AA-																		
A+																		
A																		
A-							78%	22%										
BBB+								93%				7%						
BBB								11%	78%						11%			
BBB-										50%	25%	25%						
BB+											20%	20%	40%	20%				
BB													100%					
BB-															40%	20%	40%	
B+																		
B																		
B-																		
CCC/C																		

Table 19: Rating transitions – public and private ratings (expected loss-based; relative values) – 2 years

To From	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	CCC/C	SD/D
AAA																		
AA+																		
AA																		
AA-																		
A+																		
A																		
A-							7	2										
BBB+								13				1						
BBB								1	7					1				
BBB-										2	1	1						
BB+											1	1	2	1				
BB													2					
BB-															2	1	2	
B+																		
B																		
B-																		
CCC/C																		

Table 20: Rating transitions – public and private ratings (expected loss-based; absolute values) – 2 years

To From	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	CCC/C	SD/D
AAA																		
AA+																		
AA																		
AA-																		
A+																		
A						100%												
A-							71%	29%										
BBB+								82%	9%			9%						
BBB								17%	67%					17%				
BBB-										33%	33%	33%						
BB+												25%		25%	50%			
BB													50%			50%		
BB-																	100%	
B+																		
B																		
B-																		
CCC/C																		

Table 21: Rating transitions – public and private ratings (expected loss-based; relative values) – 3 years

To From	AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	BB+	BB	BB-	B+	B	B-	CCC/C	SD/D
AAA																		
AA+																		
AA																		
AA-																		
A+																		
A						1												
A-							5	2										
BBB+								9	1			1						
BBB								1	4					1				
BBB-										1	1	1						
BB+												1		1	2			
BB													1			1		
BB-																	2	
B+																		
B																		
B-																		
CCC/C																		

Table 22: Rating transitions – public and private ratings (expected loss-based; absolute values) – 3 years

# Non-systemic Deviations

Table 23 shows correlations between the overall economic trend and the annual average probability of default-based ratings as well as annual one-year default rates. It covers the full period from 2002 to 2020. We apply time series of annual GDP growth rates in Germany and the European Union as proxies for economic development. Rating categories are mapped on a numerical scale, ranging from 1 (AAA) to 21 (C). An asterick indicates a correlation being statistically significant at the 10%-level.

Annual average ratings on the aforementioned numerical scale are correlated with GDP, i.e., economic upswings correlate with better ratings, economic downswings correlate with worse ratings. This shows that our ratings capture a significant part of the overall economic conditions. These ratings are, however, not fully correlated with the economic trend. This is in line with the assumption that credit ratings are supposed to be relatively stable over time and do not fully anticipate the economic cycle. This is also underpinned by the analysis of the historical robustness. Overall, the correlation with these ratings declined in 2020. This is likely to be due to the fact that the pandemic-understood decline in economic output did not affect the entire economy equally, but was concentrated on specific sectors in particular.

Since annual one-year default rates are not significantly correlated with the overall economic trend, we may assume that our rating portfolio does not fully reflect the overall economy. A possible explanation could be that ratings are more likely to be requested by entities, which are comparably strong to withstand economic downturns. This pattern is in line with our rating distributions. The number of investment grade ratings is significantly higher than that of speculative grade ratings.

GDP	Annual average rating (on a numerical scale)	Annual 1y default rate
Germany (annual growth rate)	-0.33*	-0.03
European Union (annual growth rate)	-0.32*	0.04

Table 23: Correlation between economic trend and ratings as well as default rates

Figure 6 shows the evolution of the annual GDP growth in Germany and the European Union as well as the annual average rating.

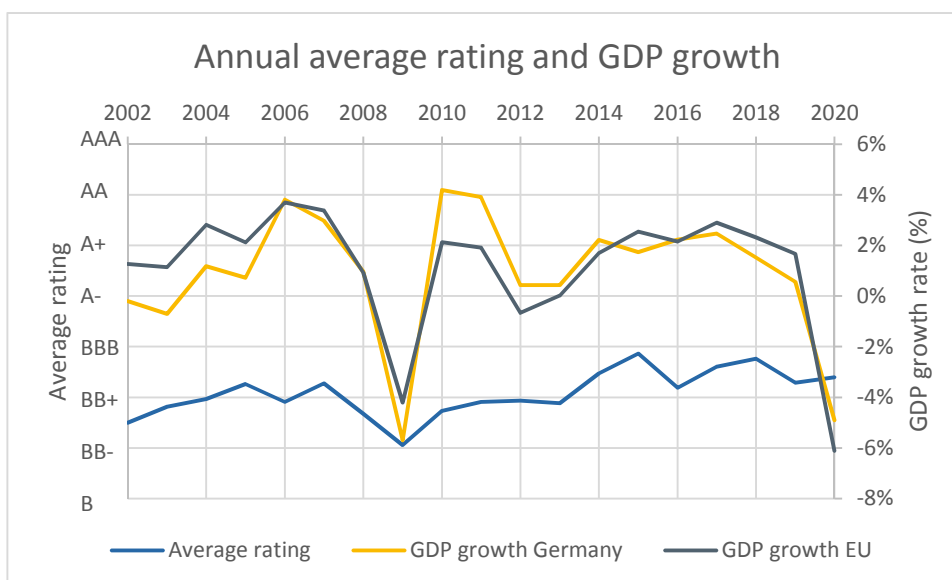


Figure 6: Annual average rating and GDP growth

# Critical Thresholds

SHG's Methodology Review Function has defined critical thresholds, which apply to the various measures presented in the above chapter. The Methodology Review Function deems these thresholds sufficient and appropriate for the purpose of validating SHG's rating methodologies.

These critical thresholds are currently not met.

If any threshold is met in the future, we will follow our predefined process for reviewing rating methodologies as set out in the SHG-internal guideline on methodology development and review.

## Appendix A: Receiver Operator Characteristic

In order to calculate the Receiver Operator Characteristic (ROC) for probability of default-based ratings, rated entities are rank-ordered according to their assigned ratings from lowest to highest. For every rating category, two key figures are calculated: Sensitivity and Specificity. Sensitivity refers to the ratio of defaults in a specific rating category plus defaults in lower rating categories over all defaults in a certain time horizon (hit rate). Specificity is the ratio of non-defaulted entities with a better rating than that specific rating category over all non-defaulted entities in that time horizon. The ROC curve plots the cumulated values of Sensitivity over (1-Specificity).

A perfect rating model would assign exclusively the lowest rating category to entities with a future default status while it would assign exclusively the highest rating category to entities with a future non-default status. Figure 10 shows the theoretical ROC curve (blue line). On the other hand, a rating methodology assigning ratings randomly would result in a ROC curve illustrated in orange.

Additionally, the Area under Curve (AUC) is calculated in order to demonstrate the discriminatory power as a single performance measure. It is defined as the area under the (actual) ROC curve. As a consequence, the AUC can range between 0 and 1, with values above 0.5 suggesting for a reasonable rating model. Higher values correspond to higher discriminatory power.

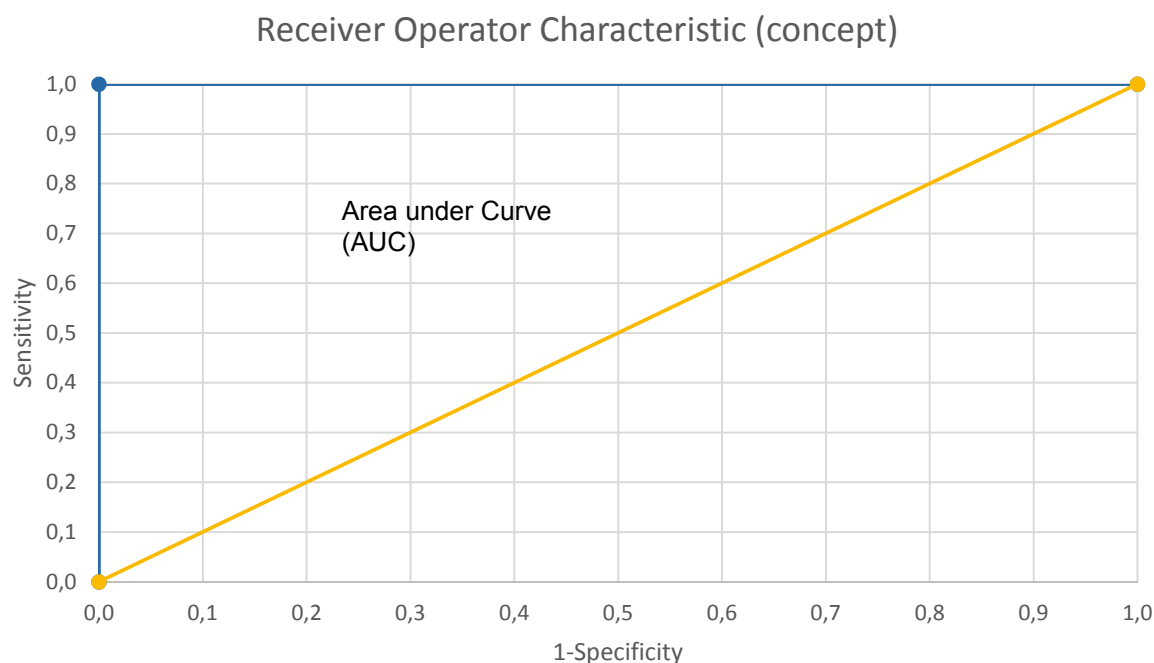


Figure 10: Receiver Operator Characteristic (concept)

## Appendix B: Rating transitions

Rating transitions for certain time horizons are calculated based on the rating change between two given points in time. We use the rating at the end of a calendar year as a reference point for the assigned rating for that corresponding year. As a result, any changes that may occur during a year are not taken into account for calculating transition rates as the relevant rating is the end of year rating.

For example, if a rated entity is assigned a BB- rating in March 2014, and no rating update changed the rating during 2014, we assume the 2014 end of year rating to be BB-. If there is a rating upgrade in February 2015 to BB and another upgrade takes place in December 2015, assigning a BB+ rating, the 2015 end of year rating would be BB+. This results in a one-year rating transition from BB- to BB+.

## Appendix C: Cumulative default rates

Cumulative default rates are calculated by averaging the default experience of cohorts made up of rated entities formed at yearly frequencies throughout the study period. The average cumulative default rate tells us the historically-observed probability of default for an entity within a particular rating category that would have otherwise remained outstanding during a specified length of time.

## Appendix D: Average Position

We define the position of any entity in a given cohort as the share of entities rated equal to or better than it, assuming each entity occupies the midpoint of its rating category. The average position (AP) is simply the average position of the defaulted entities. Intuitively, a more powerful rating system should have low-rated defaulters and high-rated non-defaulters, meaning the average position of defaulters should be high for an effective rating system. AP is bounded between 0% and 100%, with 100% indicating perfect sorting power, 50% indicating no power and 0% indicating perfectly negative power.



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