

Causal inference of server- and client-side code smells in web apps evolution - Appendix 2 : more extra data - Tables with -p-values and TE values

This appendix presents the tables with the full values. In the article they are represented by dots to resume and due to the lack of space.

1 RQ1 - Server- and client-side Code Smell evolution

All values are in the chapter 6 already.

2 RQ2 – Relationship between server- and client-side CS evolution

2.1 Correlation between Code Smell groups

Values in Appendix 6 - reproduced again on next table:

Table 1: Correlation (cor_ts) between CS groups - all apps

Correlation	phpMyAdmin	DokuWiki	OpenCart	phpBB	phpPgAdmin	MediaWiki	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Kanboard
server,client	-0.05	0.53	-0.78	0.46	-0.54	0.47	-0.34	0.4	0.57	0.37	-0.03	-0.76
server,client_js	0.14	-0.17	-0.79	0.52	0.28	-0.25	0.03	-0.53	-0.42	-0.13	0.2	-0.16
client,client_js	0.35	-0.81	0.95	-0.26	-0.08	-0.53	0.27	-0.76	-0.68	0.26	-0.35	0.34

2.2 Causal inference between Code Smell groups

2.2.1 Linear Regression - all apps

Table 2: Linear Regression between CS groups only - all apps

p-val CS only	phpMyAdmin	DokuWiki	OpenCart	phpBB	phpPgAdmin	MediaWiki	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Kanboard
server,client	0.53	0	0	0	0	0	0	0	0	0.04	0.89	0
server,client_js	0.07	0.29	0	0	0.14	0	0.82	0	0	0.47	0.27	0.2
client,server	0.53	0	0	0	0	0	0	0	0	0.04	0.89	0
client,client_js	0	0	0	0.07	0.69	0	0.02	0	0	0.16	0.04	0.01
client,server	0.07	0.29	0	0	0.14	0	0.82	0	0	0.47	0.27	0.2
client_js,client	0	0	0	0.07	0.69	0	0.02	0	0	0.16	0.04	0.01

2.2.2 Granger-causality

Table 3: Granger causality between CS groups only, up to lag 4 - p-values for all apps

Lag	Granger Causality	phpMyAdmin	DokuWiki	OpenCart	phpBB	phpPgAdmin	MediaWiki	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Kanboard
Lag 1	Server =>Client	0.19	0.09	0.98	0.63	0.45	0.9	0.41	0.76	0.7	0.71	0.47	0.58
	Server =>client_js	0.66	0.76	0.92	0.18	0.01	0.35	0.6	0.22	0.49	0.96	0.55	0.84
	Client =>Server	0.96	0.3	0.78	0.42	0.66	0.71	0	0.05	0.59	0.45	0.86	0
	Client =>Client_js	0.03	0.04	0.46	0.26	0.36	0.98	0.72	0.14	0.05	0.79	0.09	0.83
	Client =>Server	0.87	0.55	0.36	0.52	0.02	0.78	0.68	0.1	0.51	0.48	0.16	0.97
Lag 2	Client_js =>Client	0	0.91	0.65	0.08	0.84	0.07	0.9	0.13	0.1	0.26	0.02	0.5
	Server =>Client	0.4	0.34	0.92	0.88	0.64	0.21	0.93	0.95	0.25	0.8	0.09	0.01
	Server =>client_js	0.89	0.95	0.94	0.38	0.53	0.71	0.93	0.41	0.47	0.63	0.19	0.75
	Client =>Server	1	0.61	0.79	0.68	0.96	0.16	0.28	0.02	0.94	0.66	0.09	0
	Client =>Client_js	0.04	0.07	0.62	0.51	0.95	0.8	0.73	0.23	0.04	0.97	0.29	0.88
Lag 3	Client =>Server	0.99	0.84	0.75	0.8	0.28	0.56	0.88	0.21	0.87	0.87	0.03	0.99
	Client_js =>Client	0	0.92	0.86	0.18	0.88	0.1	0.24	0.29	0.18	0.51	0.02	0.65
	Server =>Client	0.61	0.45	0.99	0.98	0.72	0.33	0.69	1	0.41	0.93	0.16	0.05
	Server =>client_js	0.96	0.84	0.98	0.53	0.98	0.82	0.93	0.06	0.95	0.61	0.47	0.76
	Client =>Server	1	0.62	0.95	0.8	0.76	0.25	0.65	0.02	0.96	0.79	0.03	0.01
Lag 4	Client =>Client_js	0.04	0.28	0.99	0.66	0.92	0.93	0.88	0.22	0.15	1	0.79	0.93
	Client =>Server	1	0.7	0.81	0.91	0.15	0.69	0.95	0.26	0.77	0.97	0.05	0.98
	Client_js =>Client	0	0.83	0.93	0.3	0.98	0.17	0.26	0.54	0.2	0.68	0.02	0.84
	Server =>Client	0.74	0.61	1	0.99	0.86	0.25	0.82	0.98	0.17	0.95	0.39	0.05
	Server =>client_js	0.99	0.94	1	0.65	0.63	0.77	0.96	0.01	0.92	0.79	0.31	0.84
Lag 5	Client =>Server	1	0.62	0.96	0.85	0.48	0.7	0.79	0.02	0.99	0.89	0.05	0.11
	Client =>Client_js	0.02	0.4	0.92	0.78	0.85	0.97	0.95	0.15	0.18	1	0.1	0.8
	Client =>Server	1	0.72	0.95	0.92	0.55	0.98	0.99	0.26	0.9	0.99	0.05	0.96
	Client_js =>Client	0	0.01	0.95	0.42	0.84	0.19	0.47	0.7	0.09	0.77	0.05	0.88
	Server =>Client	0.74	0.61	1	0.99	0.86	0.25	0.82	0.98	0.17	0.95	0.39	0.05

2.2.3 Transfer entropy

Table 4: Transfer entropy between CS groups only - p values - all apps

Lag	TE p-value	phpMyAdmin	DokuWiki	OpenCart	phpBB	phpPgAdmin	MediaWiki	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Kanboard
Lag 1	Server =>Client	0.01	0.62	0.06	0.6	0.08	0.5	0.02	0.49	0.06	0.39	0.62	0.58
	Server =>client_js	0.66	0.53	0.03	0.29	0.47	0.22	0.48	0.35	0.33	0.46	0.36	0
	Client =>Server	0	0	0.12	0.01	0.18	0	0.08	0	0.67	0.53	0.35	0.06
	Client =>Client_js	0.11	0	0.12	0.05	0.09	0.18	0.81	0.05	0.58	0.5	0.13	0
	Client =>Server	0	0.41	0	0.46	0.02	0.4	0.02	0.01	0.6	0.12	0.26	0.1
	Client_js =>Client	0.03	0.89	0	0.51	0.07	0.8	0.04	0.69	0.06	0.24	0.11	0.54
Lag 2	Server =>Client	0.61	0.8	0.87	0.91	0.93	0.56	0.45	0	0.09	0.94	0.91	0.81
	Server =>client_js	0.99	0.37	0.12	0.98	0.71	0.61	0.76	0.04	0.75	0.7	0.33	0.5
	Client =>Server	0	0	0	0.02	0.87	0.45	0.6	0.19	0.91	0.92	0.9	0.7
	Client =>Client_js	0.01	0	0	0.02	0.73	0.47	0.94	0.63	0.94	0.85	0.63	0.51
	Client =>Server	0.13	0.88	0	0.94	0.38	0.39	0	0.88	0.94	0.35	0.74	0.66
	Client_js =>Client	0.34	0.98	0	0.93	0.37	0.92	0.01	0.83	0.9	0.44	0.73	0.84
Lag 3	Server =>Client	0.85	0.55	0.81	0.99	0.78	0.87	0.56	0	0.26	0.95	0.97	0.67
	Server =>client_js	1	0.82	0.55	1	0.36	0.91	0.59	0.01	0.81	0.79	0.75	0.7
	Client =>Server	0.33	0	0.97	0	0.91	0.76	0.99	0.54	1	1	0.96	0.95
	Client =>Client_js	0.08	0	0.87	0	0.66	0.92	0.98	0.91	1	0.84	0.56	0.89
	Client =>Server	0.97	0.74	0	0.99	0.94	0.91	0	0.99	0.98	1	0.81	0.7
	Client_js =>Client	0.75	0.93	0	0.99	0.3	1	0.01	0.99	1	0.76	0.5	0.88
Lag 4	Server =>Client	0.98	0.47	0.8	0.96	0.95	0.95	0.71	0.01	0.88	0.91	1	0.93
	Server =>client_js	1	0.98	0.72	0.91	0.71	0.98	0.66	0.01	0.96	0.67	0.95	0.85
	Client =>Server	0.74	0	0	0	0.97	0.87	0.86	0.9	0.99	0.98	0.74	0.87
	Client =>Client_js	0.22	0	0	0	0.89	0.82	0.69	0.76	1	0.69	0.89	0.88
	Client =>Server	1	0.93	0	0.97	1	0.99	0	0.99	1	1	0.86	0.39
	Client_js =>Client	0.95	0.92	0	0.98	0.88	1	0	0.99	1	0.9	0.97	0.88

Table 5: Transfer entropy between CS groups only - information transfer values (in %) - all apps

Lag	TE Evalues	phpMyAdmin	DokuWiki	OpenCart	phpBB	phpPgAdmin	MediaWiki	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Kanboard
Lag 1	Server =>Client	0.11	0.11	0.37	0.09	0.4	0.08	0.19	0.11	0.1	0.16	0.16	0.09
	Server =>client_js	0.04	0.13	0.41	0.14	0.26	0.11	0.09	0.12	0.06	0.16	0.21	0.27
	Client =>Server	0.11	0.11	0.33	0.17	0.32	0.13	0.16	0.35	0.07	0.15	0.25	0.19
	Client =>Client_js	0.07	0.27	0.33	0.14	0.37	0.09	0.06	0.2	0.09	0.15	0.37	0.26
	Client =>Server	0.11	0.16	0.49	0.12	0.53	0.08	0.14	0.26	0.07	0.21	0.24	0.21
	Client_js =>Client	0.08	0.06	0.42	0.1	0.42	0.05	0.11	0.1	0.16	0.17	0.29	0.13
Lag 2	Server =>Client	0.09	0.19	0.2	0.1	0.3	0.16	0.24	0.27	0.17	0.15	0.27	0.21
	Server =>client_js	0.04	0.41	0.46	0.09	0.43	0.16	0.13	0.1	0.08	0.26	0.52	0.3
	Client =>Server	0.18	0.15	0.28	0.19	0.29	0.14	0.19	0.38	0.09	0.14	0.29	0.24
	Client =>Client_js	0.13	0.35	0.34	0.18	0.34	0.13	0.12	0.3	0.11	0.2	0.46	0.29
	Client =>Server	0.11	0.25	0.38	0.15	0.58	0.17	0.23	0.17	0.09	0.26	0.35	0.29
	Client_js =>Client	0.07	0.1	0.17	0.12	0.52	0.1	0.23	0.24	0.16	0.24	0.39	0.24
Lag 3	Server =>Client	0.1	0.29	0.24	0.12	0.3	0.2	0.29	0.23	0.22	0.16	0.24	0.34
	Server =>client_js	0.05	0.36	0.32	0.12	0.47	0.18	0.2	0.17	0.12	0.24	0.41	0.35
	Client =>Server	0.13	0.11	0.2	0.28	0.24	0.17	0.16	0.41	0.1	0.09	0.23	0.27
	Client =>Client_js	0.13	0.14	0.22	0.28	0.34	0.13	0.19	0.31	0.12	0.25	0.48	0.31
	Client =>Server	0.06	0.35	0.2	0.19	0.35	0.19	0.22	0.17	0.14	0.07	0.35	0.39
	Client_js =>Client	0.07	0.16	0.14	0.13	0.54	0.12	0.19	0.24	0.15	0.23	0.51	0.31
Lag 4	Server =>Client	0.1	0.28	0.21	0.13	0.16	0.19	0.28	0.15	0.16	0.15	0.05	0.31
	Server =>client_js	0.05	0.21	0.21	0.23	0.3	0.18	0.21	0.16	0.12	0.26	0.2	0.37
	Client =>Server	0.11	0.06	0	0.23	0.12	0.12	0.24	0.29	0.11	0.09	0.24	0.35
	Client =>Client_js	0.12	0.06	0.21	0.3	0.17	0.13	0.3	0.37	0.17	0.29	0.23	0.35
	Client =>Server	0.06	0.24	0	0.22	0.05	0.16	0.2	0.15	0.15	0.08	0.24	0.46
	Client_js =>Client	0.07	0.15	0.21	0.18	0.23	0.12	0.21	0.24	0.14	0.21	0.21	0.34

3 RQ3 – Impact of CS on issues evolution

3.1 Correlation

Table 6: Correlations (Cor_ts) between CS and issues - p-values for all apps

CS\cor_ts	phpMyAdmin	DokuWiki	OpenCart	phpBB	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Kanboard
(Ex.)CyclomaticComplexity	0.55	0.39	0.07	-0.82	0.37	0.83	0.71	0.64	0.32	-0.47
(Ex.)NPathComplexity	0.58	0.46	0.11	-0.82	0.23	0.81	0.73	0.64	0.54	-0.54
ExcessiveMethodLength	0.5	0.33	0.19	-0.82	0.37	0.86	0.73	0.7	0.62	0
ExcessiveClassLength	0.23	0.35	-0.1	-0.78	0.49	0.84	0.69	0.28	0.45	-0.01
ExcessiveParameterList	0.61	-0.32	0.23	-0.43	0.55	0	0.73	-0.05	0.69	-0.42
ExcessivePublicCount	0.37	0.02	-0.27	-0.48	0.48	0.84	0.7	-0.05	0.52	0
TooManyFields	0.23	0.15	1	-0.58	0.52	0.85	0.75	0.38	0.46	-0.08
TooManyMethods	0.16	0.22	-0.32	-0.58	0.34	0.87	0.71	0.31	-0.53	0.09
TooManyPublicMethods	0.13	0.37	0.13	-0.77	0.49	0.82	0.72	0.61	-0.18	-0.14
ExcessiveClassComplexity	0.32	0.39	0.14	-0.79	0.26	0.81	0.71	0.48	0.3	-0.57
(Ex.)NumberOfChildren	0.09	0.18	-0.21	-0.37	0.48	0.65	0.63	1	0.28	-0.44
(Ex.)DepthOfInheritance	0	0	0	0	0.01	0	0	0	-0.39	0
(Ex.)CouplingBetweenObjects	-0.15	0.26	-0.21	-0.37	0.54	0.76	0.56	0.6	0.57	-0.28
DevelopmentCodeFragment	0.39	0.49	0.26	-0.24	0.44	0.81	0.52	-0.05	-0.66	0
UnusedPrivateField	-0.19	0	0.22	0	-0.47	0.74	0.62	-0.05	0.33	0
UnusedLocalVariable	-0.15	-0.57	-0.14	-0.28	-0.48	0.45	0.73	-0.04	0.82	-0.46
UnusedPrivateMethod	0.46	0	0.17	0.15	0.5	0.17	0.39	-0.05	0.67	0.24
UnusedFormalParameter	-0.41	0.14	-0.19	-0.77	-0.07	0.79	0.69	0.57	-0.38	-0.61
embed.JS	-0.48	-0.24	-0.2	-0.44	-0.33	0.77	0.74	0.33	0.81	-0.54
inline.JS	-0.39	0.78	-0.44	-0.31	-0.18	-0.83	0.7	0.72	0.85	0
embed.CSS	0.44	0.82	-0.54	0.41	0.38	0.34	0.46	0.65	0.15	-0.35
inline.CSS	0.57	-0.14	-0.43	-0.46	-0.02	0.71	0.74	0.41	0.87	-0.2
css.in.JS	0.35	-0.54	-0.53	-0.57	-0.31	0.88	-0.4	-0.06	0.75	0.32
css.in.JS.jquery	0.46	0.08	-0.56	-0.38	-0.02	0.88	-0.06	0.08	0.84	0.69
max.lines	0.33	0.4	-0.34	-0.75	-0.29	0.89	-0.24	-0.02	0.54	0.5
max.lines.per.function	0.35	0.32	-0.21	-0.64	0.03	0.89	0.25	0	0.79	0.08
max.params	0.52	0.18	-0.45	-0.4	0.55	0.76	0.07	-0.3	0.77	-0.02
(Ex.)complexity	0.49	0.42	-0.48	-0.38	0.5	0.81	0.11	-0.33	0.78	0.14
max.depth	0.62	0.18	-0.47	-0.36	0.35	0.79	-0.3	-0.16	0.72	0.06
max.nested.callbacks	0.51	0.43	-0.23	-0.32	0.46	0.85	0.41	-0.39	0.74	-0.55

3.2 Causal inference

3.2.1 Linear Regression

Table 7: Linear regression between CS and issues - p-values for all apps

CS\LM p	phpMyAdmin	DokuWiki	OpenCart	phpBB	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Kanboard
(Ex.)CyclomaticComplexity	0.05	0.08	0.36	0.00	0.55	0.64	0.74	0.90	0.03	0.09
(Ex.)NPathComplexity	0.13	0.05	0.72	0.00	0.36	0.18	0.19	0.78	0.20	0.00
ExcessiveMethodLength	0.01	0.28	0.48	0.00	0.54	0.00	0.18	0.92	0.58	0.05
ExcessiveClassLength	0.00	0.91	0.75	0.00	0.79	0.01	0.88	0.66	0.38	0.00
ExcessiveParameterList	0.47	0.00	0.55	0.07	0.13	0.00	0.46	0.00	0.75	0.00
ExcessivePublicCount	0.03	0.67	0.58	0.16	0.94	0.94	0.64	0.00	0.54	0.00
TooManyFields	0.02	0.13	all cs=1	0.01	0.95	0.07	0.93	0.81	0.26	0.00
TooManyMethods	0.76	0.86		0.53	0.11	0.86	0.00	0.71	0.64	0.06
TooManyPublicMethods	0.02	0.08	0.59	0.04	0.66	0.71	0.79	0.96	0.05	0.00
ExcessiveClassComplexity	0.00	0.09	0.65	0.00	0.40	0.25	0.97	1.00	0.18	0.04
(Ex.)NumberOfChildren	0.00	0.00	0.00	0.36	0.01	0.89	0.37	all cs=1	0.83	0.00
(Ex.)DepthOfInheritance	0.00	0.00	0.00	0.00	0.51	0.00	0.00		0.00	0.00
(Ex.)CouplingBetweenObjects	0.00	0.00	0.00	0.38	0.16	0.88	0.11	0.64	0.40	0.04
DevelopmentCodeFragment	0.00	0.02	0.56	0.13	0.12	0.43	0.06	0.00	0.03	0.00
UnusedPrivateField	0.11	0.00	0.55	0.00	0.01	0.44	0.78	0.00	0.02	0.00
UnusedLocalVariable	0.64	0.13	0.60	0.22	0.02	0.31	0.31	0.25	0.75	0.00
UnusedPrivateMethod	0.27	0.00	0.31	0.00	0.09	0.04	0.53	0.00	0.10	0.00
UnusedFormalParameter	0.05	0.09	0.67	0.00	0.25	0.77	0.22	0.73	0.09	0.03
embed.JS	0.93	0.07	0.34	0.80	0.57	0.04	0.45	0.01	0.95	0.02
inline.JS	0.94	0.79	0.50	0.47	0.76	0.05	0.68	0.03	0.87	0.00
embed.CSS	0.17	0.00	0.69	0.00	0.01	0.17	0.42	0.02	0.62	0.00
inline.CSS	0.02	0.41	0.43	0.46	0.42	0.00	0.50	0.03	0.29	0.00
css.in.JS	0.70	0.09	0.72	0.03	0.20	0.34	0.70	0.10	0.44	0.06
css.in.JS..jquery	0.08	0.97	0.73	0.27	0.56	0.06	0.36	0.02	0.01	0.00
max.lines	0.00	0.86	0.62	0.00	0.97	0.03	0.90	0.37	0.12	0.01
max.lines.per.function	0.46	0.02	0.40	0.00	0.63	0.00	0.36	0.28	0.20	0.04
max.params	0.03	0.05	0.48	0.17	0.00	0.91	0.13	0.13	0.94	0.03
(Ex.)complexity	0.03	0.02	0.48	0.32	0.01	0.94	0.27	0.16	0.67	0.07
max.depth	0.05	0.70	0.51	0.00	0.05	0.97	0.44	0.03	0.23	0.03
max.nested.callbacks	0.03	0.00	0.53	0.28	0.01	0.11	0.80	0.03	0.78	0.03

3.2.2 Granger-causality lag1 (previous release)

Table 8: Granger-causality lag 1 between CS and issues density - p-values for all apps

CS\GC lag1 p	phpMyAdmin	DokuWiki	OpenCart	phpBB	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Kanboard
(Ex.)CyclomaticComplexity	0.35	0.16	0.49	0.00	0.88	0.52	0.90	0.84	0.42	0.34
(Ex.)NPathComplexity	0.45	0.10	0.40	0.00	0.72	0.13	0.40	0.76	0.78	0.08
ExcessiveMethodLength	0.15	0.53	0.36	0.00	0.84	0.00	0.42	0.85	0.11	0.02
ExcessiveClassLength	0.00	0.56	0.54	0.00	0.69	0.08	0.84	0.64	0.29	0.63
ExcessiveParameterList	0.87	0.04	0.33	0.06	0.25	1.00	0.65	0.17	0.07	0.00
ExcessivePublicCount	0.12	0.99	0.56	0.19	0.89	0.74	0.94	0.38	0.55	1.00
TooManyFields	0.26	0.05	1.00	0.01	0.88	0.16	0.50	0.89	0.62	0.00
TooManyMethods	0.71	0.54	0.56	0.13	0.67	0.02	0.71	0.67	0.29	0.42
TooManyPublicMethods	0.02	0.15	0.34	0.04	0.93	0.58	0.88	0.90	0.74	0.00
ExcessiveClassComplexity	0.00	0.19	0.26	0.00	0.80	0.55	0.69	0.95	0.17	0.19
(Ex.)NumberOfChildren	0.03	0.00	0.91	0.40	0.06	0.57	0.58	1.00	0.17	0.00
(Ex.)DepthOfInheritance	1.00	1.00	1.00	1.00	0.91	1.00	1.00	1.00	0.54	1.00
(Ex.)CouplingBetweenObjects	0.00	0.03	0.58	0.42	0.28	0.75	0.12	0.84	0.04	0.00
DevelopmentCodeFragment	0.00	0.02	0.23	0.11	0.36	0.27	0.09	0.57	0.17	1.00
UnusedPrivateField	0.22	1.00	0.34	1.00	0.05	0.62	0.68	0.17	0.00	1.00
UnusedLocalVariable	0.55	0.21	0.63	0.16	0.18	0.98	0.58	0.87	0.04	0.00
UnusedPrivateMethod	0.81	1.00	0.51	0.76	0.21	0.12	0.60	0.17	0.14	0.93
UnusedFormalParameter	0.20	0.10	0.46	0.00	0.77	0.99	0.11	0.92	0.17	0.00
embed.JS	0.85	0.13	0.30	0.75	0.75	0.37	0.95	0.17	0.42	0.37
inline.JS	0.83	0.92	0.31	0.45	0.86	0.19	0.74	0.20	0.33	1.00
embed.CSS	0.28	0.79	0.51	0.00	0.02	0.28	0.22	0.21	0.77	0.00
inline.CSS	0.12	0.56	0.35	0.41	0.72	0.02	0.99	0.17	0.06	0.00
css.in.JS	0.68	0.15	0.26	0.02	0.36	0.28	0.63	0.17	0.39	0.22
css.in.JS.jquery	0.26	0.80	0.28	0.32	0.95	0.13	0.07	0.15	0.01	0.06
max.lines	0.01	0.70	0.39	0.00	0.77	0.33	0.84	0.90	0.44	0.24
max.lines.per.function	0.40	0.03	0.67	0.00	0.92	0.03	0.23	0.98	0.64	0.72
max.params	0.15	0.05	0.32	0.20	0.02	0.88	0.02	0.68	0.66	0.27
(Ex.)complexity	0.15	0.02	0.29	0.38	0.03	0.96	0.04	0.76	0.18	0.31
max.depth	0.22	0.57	0.28	0.29	0.22	0.79	0.11	0.13	0.89	0.28
max.nested.callbacks	0.12	0.89	0.68	0.32	0.05	0.56	0.67	0.34	0.17	0.28

3.2.3 Granger-causality lag2 (two releases before)

Table 9: Granger causality lag between CS and issues density- p-values for all apps

CS\GC lag2 p	phpMyAdmin	DokuWiki	OpenCart	phpBB	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Kanboard
(Ex.)CyclomaticComplexity	0.90	0.59	0.49	0.00	0.83	0.05	0.10	0.81	0.90	0.01
(Ex.)NPathComplexity	0.95	0.51	0.91	0.00	0.82	0.25	0.51	0.95	0.83	0.31
ExcessiveMethodLength	0.65	0.59	0.78	0.00	0.84	0.00	0.30	0.79	0.24	0.00
ExcessiveClassLength	0.06	0.34	0.64	0.00	0.67	0.14	0.89	0.49	0.36	0.17
ExcessiveParameterList	0.93	0.06	0.64	0.15	0.55	1.00	0.02	0.30	0.09	0.08
ExcessivePublicCount	0.47	0.64	0.93	0.42	0.66	0.82	0.98	0.20	0.65	1.00
TooManyFields	0.58	0.06	1.00	0.01	0.79	0.54	0.55	0.24	0.62	0.00
TooManyMethods	0.83	0.71	0.92	0.30	0.38	0.04	0.98	0.50	0.68	0.02
TooManyPublicMethods	0.15	0.58	0.76	0.08	0.83	0.31	0.70	0.71	0.30	0.00
ExcessiveClassComplexity	0.09	0.43	0.60	0.00	0.81	0.58	0.22	0.67	0.09	0.00
(Ex.)NumberOfChildren	0.21	0.00	0.86	0.70	0.21	0.23	0.17	1.00	0.23	0.01
(Ex.)DepthOfInheritance	1.00	1.00	1.00	1.00	0.29	1.00	1.00	1.00	0.64	1.00
(Ex.)CouplingBetweenObjects	0.01	0.31	0.83	0.73	0.53	0.80	0.22	0.97	0.14	0.00
DevelopmentCodeFragment	0.00	0.16	0.57	0.21	0.72	0.60	0.12	0.15	0.56	1.00
UnusedPrivateField	0.71	1.00	0.55	1.00	0.16	0.57	0.91	0.32	0.00	1.00
UnusedLocalVariable	0.91	0.74	0.88	0.17	0.61	0.50	0.28	0.98	0.05	0.00
UnusedPrivateMethod	0.90	1.00	0.74	0.95	0.58	0.44	0.62	0.30	0.42	0.97
UnusedFormalParameter	0.55	0.25	0.84	0.00	0.97	0.02	0.03	0.24	0.54	0.00
embed.JS	0.81	0.75	0.60	0.93	0.84	0.42	0.34	0.27	0.00	0.47
inline.JS	0.97	0.64	0.60	0.73	0.65	0.42	0.06	0.29	0.00	1.00
embed.CSS	0.69	0.74	0.89	0.00	0.12	0.03	0.56	0.32	0.02	0.12
inline.CSS	0.41	0.92	0.66	0.67	0.62	0.14	0.09	0.26	0.00	0.01
css.in.JS	0.50	0.73	0.41	0.03	0.75	0.71	0.48	0.34	0.51	0.01
css.in.JS.jquery	0.76	0.87	0.48	0.62	0.97	0.21	0.00	0.25	0.01	0.38
max.lines	0.19	0.73	0.75	0.00	0.91	0.04	0.13	0.95	0.64	0.45
max.lines.per.function	0.84	0.26	0.88	0.00	0.93	0.09	0.16	0.95	0.03	0.98
max.params	0.67	0.10	0.61	0.46	0.10	0.76	0.00	0.81	0.77	0.77
(Ex.)complexity	0.67	0.11	0.54	0.69	0.14	0.93	0.00	0.87	0.23	0.79
max.depth	0.75	0.69	0.53	0.59	0.42	0.19	0.00	0.23	0.35	0.75
max.nested.callbacks	0.58	0.54	0.86	0.63	0.21	0.30	0.70	0.49	0.00	0.81

3.2.4 Transfer entropy lag1 (previous release)

Table 10: Transfer entropy lag1 between CS and issues density - p-values for all apps

CS\TE lag1 p	phpMyAdmin	DokuWiki	OpenCart	phpBB	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Kanboard
CS	p	p	p	p	p	p	p	p	p	p
(Ex.)CyclomaticComplexity	0.00	0.62	0.00	0.02	0.12	0.06	0.33	0.54	0.11	0.08
(Ex.)NPathComplexity	0.00	0.62	0.49	0.02	0.33	0.10	0.14	0.54	0.33	0.01
ExcessiveMethodLength	0.00	0.88	0.01	0.02	0.36	0.04	0.32	0.54	0.22	0.16
ExcessiveClassLength	0.00	0.04	0.01	0.06	0.47	0.00	0.35	0.48	0.63	0.00
ExcessiveParameterList	0.00	0.00	0.10	0.33	0.10	0.00	0.27	0.00	0.22	0.00
ExcessivePublicCount	0.00	0.84	0.08	0.07	0.49	0.21	0.18	0.00	0.96	0.00
TooManyFields	0.00	0.07	all cs=1	0.42	0.45	0.14	0.01	0.41	0.31	0.00
TooManyMethods	0.03	0.36	0.08	0.13	0.52	0.14	0.03	0.41	0.01	0.00
TooManyPublicMethods	0.00	0.73	0.01	0.29	0.18	0.21	0.48	0.47	0.04	0.30
ExcessiveClassComplexity	0.00	0.62	0.05	0.06	0.27	0.02	0.12	0.41	0.17	0.15
(Ex.)NumberOfChildren	0.02	0.00	0.00	0.02	0.08	0.13	0.48	all cs=1	0.11	0.02
(Ex.)DepthOfInheritance	0.00	0.00	0.00	0.00	0.48	0.00	0.00	0.00	0.00	0.00
(Ex.)CouplingBetweenObjects	0.02	0.00	0.00	0.06	0.00	0.12	0.01	0.47	0.58	0.30
DevelopmentCodeFragment	0.00	0.01	0.00	0.02	0.25	0.09	0.00	0.00	0.24	0.00
UnusedPrivateField	0.00	0.00	0.01	0.00	0.28	0.01	0.45	0.00	0.79	0.00
UnusedLocalVariable	0.13	0.04	0.02	0.02	0.67	0.17	0.14	0.41	0.23	0.03
UnusedPrivateMethod	0.00	0.00	0.00	0.00	0.13	0.03	0.38	0.00	0.48	0.00
UnusedFormalParameter	0.24	0.23	0.37	0.06	0.85	0.01	0.11	0.30	0.00	0.01
embed.JS	0.34	0.22	0.01	0.18	0.57	0.01	0.03	0.46	0.20	0.17
inline.JS	0.00	0.51	0.00	0.00	0.77	0.00	0.59	0.61	0.20	0.00
embed.CSS	0.00	0.00	0.40	0.00	0.54	0.20	0.01	0.61	0.63	0.00
inline.CSS	0.34	0.42	0.01	0.19	0.81	0.01	0.03	0.72	0.80	0.00
css.in.JS	0.28	0.12	0.13	0.00	0.88	0.12	0.18	0.43	0.00	0.10
css.in.JS..jquery	0.00	0.21	0.09	0.16	0.71	0.07	0.00	0.61	0.21	0.02
max.lines	0.02	0.11	0.00	0.32	0.31	0.12	0.04	0.20	0.29	0.06
max.lines.per.function	0.19	0.00	0.00	0.60	0.34	0.27	0.07	0.51	0.19	0.30
max.params	0.00	0.00	0.00	0.09	0.58	0.03	0.06	0.04	0.04	0.02
(Ex.)complexity	0.02	0.00	0.06	0.14	0.49	0.14	0.02	0.66	0.22	0.09
max.depth	0.00	0.00	0.01	0.00	0.82	0.11	0.00	0.08	0.07	0.09
max.nested.callbacks	0.00	0.00	0.09	0.27	0.43	0.08	0.28	0.01	0.03	0.50

Table 11: Transfer entropy lag1 between CS and issues density - TE values(%) for all apps

CS\TE lag1 te	phpMyAdmin	DokuWiki	OpenCart	phpBB	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Kanboard
CS	te	te	te	te	te	te	te	te	te	te
(Ex.)CyclomaticComplexity	10%	18%	48%	41%	15%	11%	8%	13%	37%	17%
(Ex.)NPathComplexity	11%	18%	23%	41%	10%	9%	9%	13%	29%	20%
ExcessiveMethodLength	11%	10%	48%	41%	10%	17%	11%	13%	37%	14%
ExcessiveClassLength	10%	36%	51%	24%	10%	24%	10%	13%	19%	0%
ExcessiveParameterList	12%	0%	28%	25%	16%	0%	12%	0%	33%	19%
ExcessivePublicCount	10%	9%	39%	24%	9%	13%	14%	0%	9%	0%
TooManyFields	9%	30%	100%	23%	9%	15%	18%	13%	25%	0%
TooManyMethods	10%	19%	39%	22%	10%	14%	16%	13%	25%	0%
TooManyPublicMethods	14%	15%	50%	25%	10%	12%	8%	13%	44%	9%
ExcessiveClassComplexity	11%	18%	42%	24%	10%	14%	7%	13%	34%	14%
(Ex.)NumberOfChildren	9%	0%	0%	33%	12%	14%	7%	100%	31%	20%
(Ex.)DepthOfInheritance	0%	0%	0%	0%	2%	0%	0%	0%	0%	0%
(Ex.)CouplingBetweenObjects	10%	0%	0%	29%	24%	13%	18%	13%	19%	12%
DevelopmentCodeFragment	13%	40%	60%	41%	12%	15%	24%	0%	33%	0%
UnusedPrivateField	13%	0%	51%	0%	7%	19%	8%	0%	11%	0%
UnusedLocalVariable	6%	34%	43%	41%	8%	14%	9%	13%	39%	17%
UnusedPrivateMethod	10%	0%	53%	0%	13%	16%	9%	0%	18%	0%
UnusedFormalParameter	6%	21%	25%	40%	6%	15%	13%	13%	41%	18%
embed.JS	6%	18%	34%	30%	8%	22%	11%	14%	25%	12%
inline.JS	13%	12%	42%	35%	6%	29%	6%	12%	25%	0%
embed.CSS	12%	0%	25%	24%	9%	12%	22%	11%	15%	20%
inline.CSS	6%	13%	48%	29%	5%	16%	13%	10%	16%	21%
css.in.JS	7%	20%	36%	40%	6%	14%	11%	12%	62%	17%
css.in.JS..jquery	11%	13%	42%	22%	8%	16%	32%	11%	34%	16%
max.lines	9%	20%	54%	28%	9%	15%	10%	19%	28%	14%
max.lines.per.function	7%	7%	60%	18%	8%	13%	16%	14%	31%	9%
max.params	15%	7%	42%	33%	7%	20%	15%	24%	44%	16%
(Ex.)complexity	9%	7%	42%	28%	7%	12%	18%	11%	33%	13%
max.depth	13%	15%	48%	0%	5%	13%	19%	24%	47%	13%
max.nested.callbacks	9%	0%	39%	19%	9%	16%	13%	12%	44%	9%

3.2.5 Transfer entropy lag2 (two releases before)

Table 12: Transfer entropy lag2 between CS and issues density - p-values for all apps

CS\TE lag2 p	phpMyAdmin	DokuWiki	OpenCart	phpBB	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Kanboard
CS	p	p	p	p	p	p	p	p	p	p
(Ex.)CyclomaticComplexity	0.04	0.00	0.07	0.54	0.26	0.02	0.20	0.77	0.85	0.34
(Ex.)NPathComplexity	0.19	0.00	0.93	0.54	0.51	0.02	0.11	0.77	0.65	0.04
ExcessiveMethodLength	0.00	0.09	0.65	0.54	0.19	0.31	0.15	0.77	0.26	0.07
ExcessiveClassLength	0.01	0.00	0.26	0.17	0.48	0.39	0.87	0.63	0.71	0.00
ExcessiveParameterList	0.01	0.00	0.72	0.53	0.02	0.00	0.80	0.00	0.53	0.07
ExcessivePublicCount	0.01	0.09	0.55	0.09	0.45	0.71	0.37	0.00	0.48	0.00
TooManyFields	0.09	0.00	all cs=1	0.15	0.71	0.45	0.09	0.72	0.69	0.00
TooManyMethods	0.01	0.08	0.55	0.09	0.50	0.57	0.67	0.72	0.00	0.00
TooManyPublicMethods	0.00	0.02	0.59	0.73	0.35	0.57	0.87	0.73	0.33	0.03
ExcessiveClassComplexity	0.00	0.01	0.17	0.03	0.61	0.06	0.04	0.77	0.22	0.08
(Ex.)NumberOfChildren	0.04	0.00	0.00	0.67	0.05	0.31	0.31	all cs=1	0.35	0.01
(Ex.)DepthOfInheritance	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00
(Ex.)CouplingBetweenObjects	0.26	0.00	0.00	0.89	0.05	0.54	0.32	0.73	0.59	0.02
DevelopmentCodeFragment	0.00	0.28	0.36	0.54	0.18	0.55	0.05	0.00	1.00	0.00
UnusedPrivateField	0.11	0.00	0.19	0.00	0.19	0.11	0.25	0.00	0.84	0.00
UnusedLocalVariable	0.45	0.32	0.86	0.60	0.91	0.36	0.23	0.77	0.72	0.10
UnusedPrivateMethod	0.07	0.00	0.00	0.00	0.08	0.16	0.38	0.00	0.92	0.00
UnusedFormalParameter	0.00	0.02	0.46	0.65	0.48	0.02	0.45	0.38	0.00	0.01
embed.JS	0.31	0.05	0.40	0.19	0.34	0.07	0.16	0.25	0.54	0.52
inline.JS	0.32	0.12	0.00	0.01	0.35	0.01	0.68	0.33	0.54	0.00
embed.CSS	0.16	0.00	0.61	0.00	0.11	0.26	0.42	0.45	0.74	0.00
inline.CSS	0.03	0.01	0.60	0.00	0.28	0.08	0.20	0.68	0.39	0.00
css.in.JS	0.62	0.20	0.58	0.33	0.45	0.55	0.03	0.23	0.11	0.46
css.in.JS..jquery	0.01	0.16	0.21	0.86	0.41	0.28	0.06	0.45	0.34	0.00
max.lines	0.29	0.10	0.00	0.36	0.32	0.29	0.18	0.66	0.80	0.19
max.lines.per.function	0.19	0.00	0.70	0.25	0.51	0.57	0.02	0.42	0.55	0.54
max.params	0.00	0.00	0.00	0.55	0.39	0.50	0.02	0.77	0.51	0.01
(Ex.)complexity	0.00	0.00	0.00	0.31	0.32	0.76	0.01	0.91	0.36	0.03
max.depth	0.00	0.00	0.65	0.00	0.42	0.39	0.00	0.00	0.20	0.03
max.nested.callbacks	0.04	0.00	0.72	0.61	0.03	0.65	0.39	0.00	0.55	0.87

Table 13: Transfer entropy lag2 between CS and issues density - TE values(%) for all apps

CS\TE lag2 te	phpMyAdmin	DokuWiki	OpenCart	phpBB	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Kanboard
CS	te	te	te	te	te	te	te	te	te	te
(Ex.)CyclomaticComplexity	15%	73%	62%	40%	21%	21%	18%	17%	42%	25%
(Ex.)NPathComplexity	12%	73%	41%	40%	15%	19%	18%	17%	46%	33%
ExcessiveMethodLength	11%	61%	45%	40%	21%	26%	27%	17%	53%	30%
ExcessiveClassLength	16%	88%	50%	43%	20%	24%	15%	19%	42%	0%
ExcessiveParameterList	12%	0%	34%	43%	40%	0%	17%	0%	50%	23%
ExcessivePublicCount	16%	52%	54%	52%	17%	17%	24%	0%	51%	0%
TooManyFields	11%	76%	100%	65%	16%	23%	30%	17%	40%	0%
TooManyMethods	22%	62%	54%	52%	17%	21%	16%	17%	40%	0%
TooManyPublicMethods	18%	69%	45%	37%	13%	21%	12%	17%	58%	31%
ExcessiveClassComplexity	18%	71%	53%	57%	15%	14%	14%	15%	54%	30%
(Ex.)NumberOfChildren	19%	0%	0%	34%	26%	26%	20%	100%	31%	39%
(Ex.)DepthOfInheritance	0%	0%	0%	0%	10%	0%	0%	0%	0%	0%
(Ex.)CouplingBetweenObjects	18%	0%	0%	36%	36%	20%	21%	17%	47%	36%
DevelopmentCodeFragment	12%	50%	49%	40%	27%	18%	29%	0%	17%	0%
UnusedPrivateField	15%	0%	62%	0%	16%	33%	24%	0%	33%	0%
UnusedLocalVariable	12%	42%	35%	44%	12%	27%	18%	15%	51%	28%
UnusedPrivateMethod	14%	0%	54%	0%	29%	22%	20%	0%	24%	0%
UnusedFormalParameter	23%	70%	54%	42%	20%	22%	21%	16%	38%	35%
embed.JS	16%	55%	36%	55%	17%	37%	16%	35%	32%	19%
inline.JS	15%	47%	54%	35%	21%	35%	12%	28%	32%	0%
embed.CSS	17%	0%	50%	29%	21%	22%	24%	28%	32%	36%
inline.CSS	21%	53%	45%	54%	23%	23%	18%	19%	62%	36%
css.in.JS	13%	40%	51%	40%	16%	19%	33%	28%	59%	26%
css.in.JS..jquery	15%	31%	53%	29%	25%	27%	36%	28%	58%	33%
max.lines	13%	41%	45%	54%	21%	26%	17%	22%	35%	22%
max.lines.per.function	18%	11%	36%	54%	14%	24%	39%	26%	50%	18%
max.params	25%	11%	54%	44%	23%	23%	35%	18%	48%	38%
(Ex.)complexity	22%	11%	62%	52%	21%	14%	40%	13%	57%	28%
max.depth	16%	21%	45%	0%	20%	23%	40%	20%	65%	28%
max.nested.callbacks	11%	0%	46%	29%	33%	20%	23%	24%	41%	17%

4 RQ4 – Impact of CS on bugs evolution

4.1 Correlation

Table 14: Correlations(cor_ts) between CS and bugs - p-values for all apps

CS\cor_ts	phpMyAdmin	DokuWiki	OpenCart	phpBB	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Kanboard
(Ex.)CyclomaticComplexity	0.58	0.48	0.03	-0.87	0.19	0.67	0.41	0.4	-0.17	-0.21
(Ex.)NPathComplexity	0.61	0.56	0.06	-0.87	0.04	0.65	0.46	0.33	-0.01	-0.27
ExcessiveMethodLength	0.5	0.37	0.13	-0.87	0.2	0.73	0.45	0.43	0.03	0.16
ExcessiveClassLength	0.24	0.41	-0.17	-0.84	0.38	0.72	0.35	0.36	-0.05	-0.15
ExcessiveParameterList	0.6	-0.33	0.18	-0.48	0.41	0	0.46	0.22	0.32	0.01
ExcessivePublicCount	0.4	0.03	-0.31	-0.56	0.33	0.75	0.36	0.22	0.03	0
TooManyFields	0.3	0.07	1	-0.62	0.39	0.68	0.41	0.41	-0.03	-0.22
TooManyMethods	0.21	0.13	-0.36	-0.66	0.21	0.75	0.46	0.41	-0.34	-0.01
TooManyPublicMethods	0.15	0.52	0.09	-0.82	0.21	0.68	0.44	0.41	-0.3	-0.08
ExcessiveClassComplexity	0.31	0.32	0.09	-0.85	0.21	0.73	0.42	0.31	-0.11	-0.36
(Ex.)NumberOfChildren	0.05	0.3	-0.21	-0.38	0.4	0.53	0.48	1	0.12	0.02
(Ex.)DepthOfInheritance	0	0	0	0	0.03	0	0	0	-0.74	0
(Ex.)CouplingBetweenObjects	-0.13	0.46	-0.21	-0.38	0.42	0.77	0.23	0.41	0.05	0.15
DevelopmentCodeFragment	0.45	0.72	0.23	-0.27	0.2	0.63	0.19	0.22	-0.59	0
UnusedPrivateField	-0.18	0	0.22	0	-0.34	0.73	0.3	0.22	0.06	0
UnusedLocalVariable	-0.09	-0.69	-0.17	-0.33	-0.34	0.31	0.43	-0.24	0.37	-0.35
UnusedPrivateMethod	0.49	0	0.07	0.01	0.39	0.38	0.29	0.22	0.17	0.4
UnusedFormalParameter	-0.37	0.21	-0.22	-0.85	-0.01	0.61	0.38	0.68	-0.31	-0.24
embed.JS	-0.42	-0.45	-0.23	-0.49	-0.21	0.64	0.44	0.5	0.53	-0.32
inline.JS	-0.33	0.83	-0.43	-0.33	-0.26	-0.66	0.39	0.5	0.42	0
embed.CSS	0.49	0.83	-0.51	0.44	0.26	0.06	0.12	0.37	0.08	0
inline.CSS	0.56	-0.27	-0.47	-0.52	0.02	0.7	0.47	0.56	0.42	0.26
css.in.JS	0.4	-0.62	-0.52	-0.63	-0.17	0.75	-0.28	0.22	0.29	0.46
css.in.JS.jquery	0.49	0.16	-0.55	-0.42	0.06	0.73	0.1	-0.01	0.4	0.74
max.lines	0.38	0.5	-0.35	-0.79	-0.2	0.7	-0.24	0.24	0.27	0.63
max.lines.per.function	0.4	0.44	-0.21	-0.69	0.02	0.74	0.1	0.25	0.33	0.12
max.params	0.53	0.25	-0.44	-0.46	0.48	0.72	0.18	0.02	0.35	0.4
(Ex.)complexity	0.51	0.47	-0.47	-0.44	0.46	0.74	0.18	0.03	0.36	0.52
max.depth	0.59	0.21	-0.45	-0.42	0.32	0.63	-0.1	0.18	0.3	0.42
max.nested.callbacks	0.45	0.07	-0.23	-0.38	0.37	0.76	0.17	0	0.32	-0.17

4.2 Causal inference

4.2.1 Linear Regression

Table 15: Linear regression between CS and bugs - p-values for all apps

CS\LM p-val	phpMyAdmin	DokuWiki	OpenCart	phpBB	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Kanboard
(Ex.)CyclomaticComplexity	0.12	0.02	0.78	0.00	0.81	0.11	0.02	0.49	0.20	0.17
(Ex.)NPathComplexity	0.31	0.02	0.47	0.00	0.96	0.79	0.00	0.54	0.59	0.22
ExcessiveMethodLength	0.01	0.04	0.40	0.01	0.79	0.00	0.00	0.48	0.82	0.70
ExcessiveClassLength	0.00	0.18	0.58	0.00	0.20	0.00	0.98	0.46	0.75	0.97
ExcessiveParameterList	0.43	0.24	0.56	0.18	0.00	0.00	0.00	0.49	0.93	0.04
ExcessivePublicCount	0.02	0.17	0.83	0.09	0.36	0.27	0.00	0.31	0.87	0.00
TooManyFields	0.97	0.84	all cs=1	0.01	0.27	0.03	0.02	0.41	0.71	0.08
TooManyMethods	0.07	0.47	0.84	0.06	0.36	0.00	0.01	0.43	0.34	0.03
TooManyPublicMethods	0.00	0.03	0.55	0.03	0.61	0.22	0.14	0.48	0.37	0.00
ExcessiveClassComplexity	0.00	0.01	0.55	0.00	0.89	0.00	0.01	0.47	0.46	0.76
(Ex.)NumberOfChildren	0.00	0.01	0.00	0.24	0.00	0.15	0.77	all cs=1	0.77	0.01
(Ex.)DepthOfInheritance	0.00	0.00	0.00	0.00	0.34	0.00	0.00	0.00	0.18	0.00
(Ex.)CouplingBetweenObjects	0.00	0.13	0.00	0.26	0.00	0.05	0.40	0.67	0.96	0.61
DevelopmentCodeFragment	0.00	0.07	0.42	0.24	0.12	0.28	0.53	0.33	0.21	0.00
UnusedPrivateField	0.97	0.00	0.39	0.00	0.00	0.15	0.04	0.63	0.04	0.00
UnusedLocalVariable	0.53	0.04	0.51	0.33	0.10	0.00	0.00	0.69	0.76	0.00
UnusedPrivateMethod	0.08	0.00	0.61	0.61	0.00	0.01	0.07	0.49	0.32	0.07
UnusedFormalParameter	0.48	0.20	0.42	0.00	0.94	0.03	0.06	0.37	0.42	0.00
embed.JS	0.07	0.02	0.44	0.91	0.29	0.00	0.00	0.44	0.19	0.42
inline.JS	0.06	0.37	0.39	0.77	0.19	0.00	0.00	0.68	0.13	0.00
embed.CSS	0.35	0.41	0.81	0.00	0.00	0.79	0.70	0.55	0.41	0.10
inline.CSS	0.74	0.15	0.41	0.71	0.36	0.00	0.00	0.62	0.05	0.02
css.in.JS	0.49	0.04	0.45	0.07	0.20	0.09	0.05	0.61	0.31	0.67
css.in.JS..jquery	0.30	0.60	0.41	0.14	0.72	0.03	0.73	0.55	0.03	0.00
max.lines	0.10	0.45	0.33	0.00	0.44	0.00	0.00	0.76	0.48	0.26
max.lines.per.function	0.16	0.03	0.69	0.00	0.90	0.03	0.25	0.79	0.96	0.30
max.params	0.82	0.18	0.38	0.08	0.00	0.08	0.80	0.74	0.25	0.34
(Ex.)complexity	0.83	0.06	0.38	0.16	0.00	0.03	0.92	0.77	0.81	0.37
max.depth	0.85	0.80	0.37	0.12	0.02	0.79	0.22	0.53	0.74	0.30
max.nested.callbacks	0.67	0.99	0.60	0.15	0.00	0.00	0.29	0.55	0.45	0.52

4.2.2 Granger-causality lag1 (previous release)

Table 16: Granger-causality lag 1 between CS and bugs - p-values for all apps

CS\GClag1 p-val	phpMyAdmin	DokuWiki	OpenCart	phpBB	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Kanboard
(Ex.)CyclomaticComplexity	0.28	0.04	0.70	0.00	0.68	0.44	0.09	0.66	0.83	0.20
(Ex.)NPathComplexity	0.49	0.02	0.49	0.00	0.81	0.73	0.00	0.69	0.66	0.34
ExcessiveMethodLength	0.04	0.12	0.32	0.00	0.72	0.02	0.02	0.64	0.18	0.26
ExcessiveClassLength	0.00	0.51	0.70	0.00	0.32	0.02	0.89	0.52	0.25	0.99
ExcessiveParameterList	0.66	0.15	0.73	0.13	0.07	1.00	0.01	0.57	0.15	0.32
ExcessivePublicCount	0.05	0.50	0.62	0.11	0.45	0.60	0.01	0.50	0.59	1.00
TooManyFields	0.79	0.41	1.00	0.00	0.38	0.08	0.16	0.58	0.59	0.70
TooManyMethods	0.08	0.99	0.61	0.08	0.38	0.07	0.05	0.58	0.68	0.53
TooManyPublicMethods	0.00	0.05	0.60	0.02	0.59	0.61	0.28	0.64	0.81	0.06
ExcessiveClassComplexity	0.00	0.02	0.88	0.00	0.71	0.05	0.09	0.62	0.37	0.55
(Ex.)NumberOfChildren	0.00	0.00	0.45	0.28	0.00	0.58	0.63	1.00	0.61	0.17
(Ex.)DepthOfInheritance	1.00	1.00	1.00	1.00	0.81	1.00	1.00	1.00	0.64	1.00
(Ex.)CouplingBetweenObjects	0.00	0.09	0.33	0.30	0.07	0.30	0.70	0.67	0.18	0.67
DevelopmentCodeFragment	0.00	0.04	0.63	0.17	0.41	0.17	0.52	0.52	0.54	1.00
UnusedPrivateField	0.80	1.00	0.43	1.00	0.06	0.26	0.22	0.62	0.00	1.00
UnusedLocalVariable	0.89	0.05	0.29	0.23	0.44	0.11	0.02	0.87	0.21	0.05
UnusedPrivateMethod	0.33	1.00	0.46	0.68	0.06	0.03	0.24	0.57	0.29	0.99
UnusedFormalParameter	0.66	0.18	0.41	0.00	0.71	0.20	0.17	0.61	0.45	0.29
embed.JS	0.26	0.03	0.38	0.95	0.54	0.04	0.06	0.72	0.02	0.62
inline.JS	0.24	0.46	0.50	0.63	0.25	0.01	0.05	0.85	0.01	1.00
embed.CSS	0.70	0.57	0.88	0.00	0.01	0.91	0.64	0.80	0.12	0.33
inline.CSS	0.97	0.19	0.45	0.56	0.73	0.01	0.03	0.79	0.00	0.41
css.in.JS	0.94	0.05	0.84	0.04	0.43	0.08	0.34	0.61	0.59	0.83
css.in.JS.jquery	0.45	0.78	0.77	0.19	0.63	0.12	0.18	0.70	0.01	0.01
max.lines	0.19	0.62	0.32	0.00	0.57	0.01	0.05	0.81	0.83	0.44
max.lines.per.function	0.45	0.03	0.40	0.00	0.99	0.36	0.55	0.83	0.65	0.45
max.params	0.94	0.15	0.38	0.11	0.00	0.37	0.34	0.93	0.06	0.50
(Ex.)complexity	0.93	0.04	0.41	0.23	0.01	0.22	0.37	0.88	0.25	0.50
max.depth	0.94	0.95	0.46	0.17	0.20	0.96	0.97	0.65	0.47	0.48
max.nested.callbacks	0.97	1.00	0.38	0.19	0.05	0.05	0.94	0.92	0.04	0.60

4.2.3 Granger-causality lag2 (two releases before)

Table 17: Granger-causality lag2 between CS and bugs - p-values for all apps

CS\GClag2 p-val	phpMyAdmin	DokuWiki	OpenCart	phpBB	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Kanboard
(Ex.)CyclomaticComplexity	0.79	0.10	0.46	0.00	0.62	0.17	0.14	0.81	0.75	0.09
(Ex.)NPathComplexity	0.76	0.07	0.34	0.00	0.64	0.79	0.03	0.95	0.72	0.66
ExcessiveMethodLength	0.32	0.12	0.16	0.00	0.69	0.05	0.04	0.76	0.11	0.65
ExcessiveClassLength	0.01	0.13	0.82	0.00	0.39	0.12	0.79	0.65	0.18	0.57
ExcessiveParameterList	0.76	0.04	0.78	0.25	0.32	1.00	0.01	0.63	0.18	0.65
ExcessivePublicCount	0.30	0.10	0.49	0.24	0.49	0.96	0.10	0.54	0.75	1.00
TooManyFields	0.86	0.05	1.00	0.00	0.58	0.38	0.37	0.46	0.67	0.76
TooManyMethods	0.30	0.37	0.46	0.17	0.32	0.11	0.19	0.67	0.79	0.43
TooManyPublicMethods	0.00	0.12	0.38	0.03	0.61	0.59	0.75	0.75	0.38	0.29
ExcessiveClassComplexity	0.02	0.08	0.83	0.00	0.58	0.27	0.20	0.72	0.30	0.73
(Ex.)NumberOfChildren	0.02	0.02	0.37	0.54	0.04	0.68	0.36	1.00	0.71	0.20
(Ex.)DepthOfInheritance	1.00	1.00	1.00	1.00	0.24	1.00	1.00	1.00	0.84	1.00
(Ex.)CouplingBetweenObjects	0.01	0.60	0.20	0.58	0.31	0.69	0.97	0.93	0.21	0.98
DevelopmentCodeFragment	0.00	0.14	0.59	0.28	0.46	0.50	0.44	0.49	0.97	1.00
UnusedPrivateField	0.99	1.00	0.29	1.00	0.25	0.65	0.61	0.67	0.00	1.00
UnusedLocalVariable	0.97	0.25	0.17	0.21	0.86	0.49	0.01	0.93	0.20	0.43
UnusedPrivateMethod	0.90	1.00	0.38	0.90	0.25	0.20	0.44	0.63	0.62	0.78
UnusedFormalParameter	0.66	0.16	0.24	0.00	0.77	0.06	0.09	0.57	0.88	0.73
embed.JS	0.67	0.48	0.22	0.94	0.90	0.22	0.16	0.78	0.00	0.01
inline.JS	0.68	0.87	0.41	0.81	0.49	0.10	0.03	0.76	0.00	1.00
embed.CSS	0.95	0.96	0.54	0.00	0.08	0.12	0.97	0.82	0.00	0.61
inline.CSS	0.68	0.89	0.29	0.73	0.59	0.07	0.04	0.75	0.00	0.60
css.in.JS	0.69	0.44	0.76	0.06	0.84	0.37	0.91	0.66	0.46	0.30
css.in.JS.jquery	0.83	0.97	0.71	0.42	0.73	0.32	0.00	0.74	0.00	0.12
max.lines	0.68	0.96	0.11	0.00	0.87	0.03	0.15	0.95	0.41	0.68
max.lines.per.function	0.77	0.21	0.28	0.00	1.00	0.46	0.34	0.97	0.02	0.71
max.params	0.95	0.24	0.30	0.26	0.02	0.63	0.00	0.96	0.20	0.84
(Ex.)complexity	0.95	0.10	0.31	0.48	0.05	0.71	0.00	0.96	0.07	0.84
max.depth	0.94	0.89	0.36	0.38	0.53	0.28	0.00	0.68	0.06	0.81
max.nested.callbacks	0.99	0.97	0.27	0.42	0.21	0.28	0.88	0.88	0.00	0.75

4.2.4 Transfer entropy lag1 (previous release)

Table 18: Transfer entropy lag1 between CS and bugs - p-values for all apps

CS\TElag1 p-val	phpMyAdmin	DokuWiki	OpenCart	phpBB	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Kanboard
(Ex.)CyclomaticComplexity	0.00	0.07	0.27	0.02	0.71	0.06	0.01	0.54	0.06	0.15
(Ex.)NPathComplexity	0.00	0.07	0.48	0.02	0.78	0.06	0.00	0.54	0.10	0.13
ExcessiveMethodLength	0.00	0.00	0.08	0.02	0.58	0.46	0.18	0.54	0.41	0.01
ExcessiveClassLength	0.00	0.00	0.04	0.18	0.72	0.29	0.05	0.48	0.00	0.61
ExcessiveParameterList	0.00	0.00	0.52	0.14	0.10	0.00	0.04	0.14	0.07	0.00
ExcessivePublicCount	0.00	0.00	0.03	0.09	0.93	0.13	0.14	0.30	0.38	0.00
TooManyFields	0.00	0.00	all cs=1	0.19	0.89	0.79	0.03	0.41	0.38	0.10
TooManyMethods	0.00	0.00	0.03	0.09	0.79	0.39	0.03	0.41	0.11	0.77
TooManyPublicMethods	0.00	0.16	0.23	0.22	0.57	0.22	0.05	0.47	0.06	0.69
ExcessiveClassComplexity	0.00	0.00	0.20	0.18	0.80	0.10	0.02	0.41	0.05	0.00
(Ex.)NumberOfChildren	0.00	0.00	0.00	0.01	0.04	0.71	0.10	all cs=1	0.01	0.36
(Ex.)DepthOfInheritance	0.00	0.00	0.00	0.00	0.39	0.00	0.00	0.00	0.00	0.00
(Ex.)CouplingBetweenObjects	0.02	0.00	0.00	0.02	0.02	0.24	0.04	0.47	0.05	0.04
DevelopmentCodeFragment	0.00	0.19	0.02	0.02	0.68	0.50	0.01	0.30	0.01	0.00
UnusedPrivateField	0.00	0.00	0.10	0.00	0.00	0.15	0.03	0.00	0.11	0.00
UnusedLocalVariable	0.32	0.09	0.24	0.05	0.97	0.25	0.01	0.41	0.29	0.51
UnusedPrivateMethod	0.00	0.00	0.10	0.62	0.19	0.15	0.05	0.14	0.03	0.09
UnusedFormalParameter	0.55	0.07	0.50	0.13	0.98	0.07	0.07	0.30	0.10	0.72
embed.JS	0.00	0.00	0.02	0.28	0.96	0.44	0.01	0.46	0.01	0.32
inline.JS	0.13	0.19	0.00	0.00	0.90	0.01	0.09	0.61	0.01	0.00
embed.CSS	0.00	0.19	0.75	0.00	0.36	0.46	0.02	0.61	0.10	0.00
inline.CSS	0.23	0.00	0.09	0.04	0.85	0.01	0.10	0.72	0.01	0.01
css.in.JS	0.14	0.00	0.48	0.01	0.99	0.02	0.01	0.43	0.20	0.06
css.in.JS..jquery	0.00	0.00	0.23	0.09	0.73	0.23	0.00	0.61	0.11	0.37
max.lines	0.08	0.03	0.00	0.24	0.81	0.06	0.00	0.20	0.22	0.09
max.lines.per.function	0.30	0.00	0.42	0.51	0.86	0.17	0.00	0.51	0.18	0.47
max.params	0.00	0.00	0.00	0.00	0.56	0.04	0.01	0.04	0.06	0.19
(Ex.)complexity	0.01	0.00	0.10	0.11	0.50	0.12	0.00	0.66	0.01	0.16
max.depth	0.00	0.00	0.08	0.00	0.87	0.72	0.00	0.08	0.14	0.16
max.nested.callbacks	0.00	0.10	0.70	0.12	0.54	0.07	0.19	0.01	0.00	0.12

Table 19: Transfer entropy lag1 between CS and bugs - TE values(%) for all apps

CS\TElag1 te	phpMyAdmin	DokuWiki	OpenCart	phpBB	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Kanboard
(Ex.)CyclomaticComplexity	10%	34%	22%	38%	7%	10%	14%	13%	42%	13%
(Ex.)NPathComplexity	15%	34%	23%	38%	3%	10%	16%	13%	46%	13%
ExcessiveMethodLength	11%	51%	37%	38%	7%	10%	14%	13%	32%	19%
ExcessiveClassLength	11%	52%	40%	20%	7%	11%	16%	13%	80%	2%
ExcessiveParameterList	10%	60%	14%	31%	16%	0%	18%	14%	52%	16%
ExcessivePublicCount	10%	51%	41%	23%	3%	15%	14%	13%	32%	0%
TooManyFields	10%	78%	100%	30%	3%	7%	17%	13%	32%	4%
TooManyMethods	13%	59%	41%	23%	7%	10%	17%	13%	36%	6%
TooManyPublicMethods	16%	30%	29%	27%	3%	13%	15%	13%	42%	4%
ExcessiveClassComplexity	10%	59%	31%	20%	3%	8%	13%	13%	57%	31%
(Ex.)NumberOfChildren	13%	50%	0%	37%	15%	6%	12%	100%	68%	10%
(Ex.)DepthOfInheritance	0%	0%	0%	0%	3%	0%	0%	0%	32%	0%
(Ex.)CouplingBetweenObjects	10%	43%	0%	33%	19%	11%	15%	13%	52%	21%
DevelopmentCodeFragment	12%	28%	46%	38%	7%	9%	18%	13%	55%	0%
UnusedPrivateField	13%	0%	36%	0%	23%	11%	17%	12%	36%	0%
UnusedLocalVariable	5%	28%	26%	38%	3%	13%	14%	13%	36%	7%
UnusedPrivateMethod	13%	0%	36%	2%	12%	10%	16%	14%	58%	7%
UnusedFormalParameter	5%	30%	21%	35%	3%	9%	15%	13%	46%	6%
embed.JS	13%	55%	33%	26%	3%	11%	13%	14%	58%	9%
inline.JS	8%	19%	53%	36%	3%	17%	13%	12%	58%	0%
embed.CSS	12%	19%	15%	20%	11%	9%	19%	11%	35%	15%
inline.CSS	7%	43%	37%	39%	4%	16%	10%	10%	61%	14%
css.in.JS	8%	48%	22%	38%	3%	19%	19%	12%	41%	19%
css.in.JS..jquery	10%	45%	31%	27%	7%	11%	33%	11%	50%	8%
max.lines	8%	26%	42%	30%	3%	17%	15%	19%	30%	13%
max.lines.per.function	6%	14%	22%	20%	3%	15%	21%	14%	29%	7%
max.params	15%	14%	53%	50%	7%	17%	21%	24%	49%	10%
(Ex.)complexity	10%	14%	37%	30%	6%	13%	24%	11%	66%	11%
max.depth	11%	30%	37%	24%	4%	6%	35%	24%	46%	11%
max.nested.callbacks	13%	18%	17%	23%	8%	17%	14%	12%	76%	14%

4.2.5 Transfer entropy lag2 (two releases before)

Table 20: Transfer entropy lag2 between CS and bugs - p-values for all apps

CS\TElag2 p-val	phpMyAdmin	DokuWiki	OpenCart	phpBB	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Karboard
(Ex.)CyclomaticComplexity	0.06	0.42	0.11	0.57	0.15	0.02	0.54	0.77	0.26	0.65
(Ex.)NPathComplexity	0.04	0.42	0.99	0.57	0.31	0.02	0.37	0.77	0.80	0.83
ExcessiveMethodLength	0.00	0.51	0.10	0.57	0.27	0.54	0.59	0.77	0.56	0.41
ExcessiveClassLength	0.06	0.66	0.18	0.17	0.60	0.58	0.96	0.63	0.43	0.62
ExcessiveParameterList	0.03	0.00	0.53	0.55	0.28	0.00	0.51	0.32	0.00	0.05
ExcessivePublicCount	0.04	0.60	0.62	0.26	0.43	0.67	0.69	0.38	0.73	0.00
TooManyFields	0.11	0.36	all cs=1	0.27	0.57	0.32	0.06	0.72	0.73	0.11
TooManyMethods	0.04	0.62		0.62	0.25	0.62	0.50	0.88	0.72	0.00
TooManyPublicMethods	0.00	0.57	0.10	0.51	0.16	0.82	0.63	0.73	0.28	0.80
ExcessiveClassComplexity	0.00	0.36	0.09	0.04	0.36	0.07	0.07	0.77	0.33	0.15
(Ex.)NumberOfChildren	0.02	0.49	0.00	0.81	0.09	0.57	0.56	all cs=1	0.52	0.97
(Ex.)DepthOfInheritance	0.00	0.00	0.00	0.00	0.85	0.00	0.00		0.00	0.00
(Ex.)CouplingBetweenObjects	0.39	0.44	0.00	0.97	0.15	0.84	0.23	0.73	0.69	0.05
DevelopmentCodeFragment	0.00	0.89	0.24	0.57	0.40	0.71	0.21	0.38	0.11	0.00
UnusedPrivateField	0.00	0.00	0.23	0.00	0.04	0.68	0.88	0.00	0.05	0.00
UnusedLocalVariable	0.08	0.41	0.79	0.47	0.68	0.36	0.63	0.77	0.35	0.47
UnusedPrivateMethod	0.11	0.00	0.00	0.88	0.48	0.38	0.86	0.32	0.27	0.36
UnusedFormalParameter	0.00	0.51	0.85	0.41	0.20	0.00	0.86	0.38	0.00	0.21
embed.JS	0.07	0.81	0.61	0.42	0.33	0.34	0.50	0.25	0.15	0.38
inline.JS	0.00	0.30	0.00	0.01	0.21	0.29	0.78	0.33	0.15	0.00
embed.CSS	0.03	0.30	0.75	0.00	0.53	0.21	0.70	0.45	0.11	0.45
inline.CSS	0.01	0.18	0.09	0.00	0.54	0.00	0.28	0.68	0.48	0.55
css.in.JS	0.70	0.82	0.32	0.39	0.25	0.13	0.09	0.23	0.65	0.33
css.in.JS..jquery	0.02	0.06	0.13	0.90	0.88	0.39	0.11	0.45	0.14	0.70
max.lines	0.62	0.44	0.00	0.46	0.25	0.28	0.45	0.66	0.48	0.44
max.lines.per.function	0.36	0.00	0.79	0.20	0.47	0.63	0.05	0.42	0.14	0.88
max.params	0.01	0.00	0.00	0.61	0.65	0.23	0.05	0.77	0.04	0.77
(Ex.)complexity	0.22	0.00	0.00	0.40	0.58	0.69	0.08	0.91	0.19	0.57
max.depth	0.00	0.00	0.10	0.00	0.71	0.38	0.00	0.00	0.29	0.57
max.nested.callbacks	0.00	0.68	0.80	0.70	0.34	0.26	0.52	0.00	0.21	0.65

Table 21: Transfer entropy lag2 between CS and bugs - TE values(%) for all apps

CS\TElag2 te	phpMyAdmin	DokuWiki	OpenCart	phpBB	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Kanboard
(Ex.)CyclomaticComplexity	15%	47%	54%	43%	23%	19%	13%	17%	57%	17%
(Ex.)NPathComplexity	15%	47%	20%	43%	18%	21%	13%	17%	37%	12%
ExcessiveMethodLength	11%	45%	62%	43%	18%	19%	19%	17%	35%	17%
ExcessiveClassLength	15%	45%	52%	46%	17%	19%	11%	19%	53%	2%
ExcessiveParameterList	11%	45%	39%	46%	23%	0%	23%	20%	53%	22%
ExcessivePublicCount	16%	37%	45%	47%	17%	16%	18%	16%	41%	0%
TooManyFields	12%	47%	100%	65%	17%	24%	33%	17%	41%	8%
TooManyMethods	22%	40%	45%	46%	14%	20%	12%	17%	53%	10%
TooManyPublicMethods	21%	41%	62%	51%	17%	15%	17%	17%	57%	8%
ExcessiveClassComplexity	17%	51%	55%	58%	19%	12%	12%	15%	57%	26%
(Ex.)NumberOfChildren	21%	42%	0%	33%	21%	19%	17%	100%	45%	6%
(Ex.)DepthOfInheritance	0%	0%	0%	0%	2%	0%	0%	0%	26%	0%
(Ex.)CouplingBetweenObjects	17%	46%	0%	35%	27%	13%	25%	17%	42%	31%
DevelopmentCodeFragment	15%	28%	50%	43%	20%	14%	23%	16%	53%	0%
UnusedPrivateField	21%	0%	56%	0%	22%	20%	13%	17%	57%	0%
UnusedLocalVariable	17%	43%	35%	53%	17%	25%	12%	15%	57%	17%
UnusedPrivateMethod	14%	0%	62%	4%	18%	17%	12%	20%	53%	7%
UnusedFormalParameter	26%	40%	33%	56%	24%	27%	14%	16%	53%	21%
embed.JS	21%	28%	27%	51%	17%	26%	11%	35%	51%	19%
inline.JS	27%	44%	62%	37%	22%	18%	11%	28%	51%	0%
embed.CSS	23%	44%	39%	34%	12%	22%	20%	28%	66%	11%
inline.CSS	23%	44%	62%	65%	17%	30%	17%	19%	53%	12%
css.in.JS	14%	22%	56%	40%	19%	26%	28%	28%	35%	26%
css.in.JS..jquery	16%	44%	54%	28%	14%	23%	34%	28%	53%	6%
max.lines	11%	31%	62%	55%	21%	24%	12%	22%	48%	15%
max.lines.per.function	17%	12%	27%	62%	14%	21%	33%	26%	66%	9%
max.params	22%	12%	62%	47%	17%	27%	32%	18%	47%	8%
(Ex.)complexity	16%	12%	63%	53%	15%	14%	33%	13%	66%	12%
max.depth	14%	27%	62%	35%	14%	22%	39%	20%	57%	12%
max.nested.callbacks	16%	15%	37%	28%	20%	26%	22%	24%	52%	19%

5 RQ5 – Impact CS time to release (TTR)

5.1 Causal inference

5.1.1 Linear Regression

Table 22: Linear regression between CS and TTR - p-values for all apps

CS\LM p-value	phpMyAdmin	DokuWiki	OpenCart	phpBB	phpPgAdmin	MediaWiki	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Kanboard
(Ex.)CyclomaticComplexity	0.00	0.19	0.14	0.00	0.55	0.00	0.05	0.71	0.00	0.30	0.48	0.00
(Ex.)NPathComplexity	0.00	0.37	0.29	0.00	0.74	0.00	0.03	0.16	0.00	0.34	0.19	0.00
ExcessiveMethodLength	0.00	0.43	0.05	0.00	0.11	0.00	0.04	0.00	0.00	0.29	0.61	0.46
ExcessiveClassLength	0.00	0.41	0.61	0.01	0.17	0.00	0.13	0.00	0.39	0.10	0.19	0.00
ExcessiveParameterList	0.00	0.00	0.69	0.00	0.27	0.00	0.26	0.00	0.00	0.00	0.92	0.70
ExcessivePublicCount	0.00	0.22	0.02	0.43	0.58	0.06	0.10	0.63	0.00	0.00	0.10	0.00
TooManyFields	0.11	0.28	all cs=1	0.08	0.00	0.00	0.19	0.24	0.00	0.20	0.21	0.00
TooManyMethods	0.01	0.24	0.01	0.18	0.41	0.00	0.15	0.75	0.00	0.09	0.03	0.00
TooManyPublicMethods	0.00	0.11	0.32	0.14	0.32	0.11	0.05	0.16	0.00	0.24	0.06	0.26
ExcessiveClassComplexity	0.00	0.29	0.77	0.01	0.17	0.00	0.03	0.65	0.03	0.22	0.67	0.00
(Ex.)NumberOfChildren	0.00	0.00	0.00	0.78	0.00	0.00	0.89	0.99	0.72	all cs=1	0.67	0.09
(Ex.)DepthOfInheritance	0.00	0.00	0.00	0.00	0.01	0.00	0.94	0.00	0.00	0.00	0.00	0.00
(Ex.)CouplingBetweenObjects	0.00	0.00	0.00	0.78	0.00	0.00	0.20	0.67	0.53	0.23	0.03	0.35
DevelopmentCodeFragment	0.00	0.26	0.53	0.06	0.00	0.01	0.95	0.48	0.00	0.00	0.04	0.00
UnusedPrivateField	0.01	0.00	0.08	0.00	0.00	0.11	0.88	0.57	0.02	0.00	0.23	0.00
UnusedLocalVariable	0.00	0.79	0.08	0.01	0.53	0.00	0.30	0.35	0.00	0.40	0.37	0.19
UnusedPrivateMethod	0.00	0.00	0.32	0.00	0.00	0.00	0.43	0.26	0.00	0.00	0.02	0.00
UnusedFormalParameter	0.00	0.27	0.01	0.07	0.26	0.41	0.04	0.44	0.00	0.21	0.02	0.36
embed.JS	0.00	0.78	0.16	0.00	0.57	0.00	0.41	0.56	0.00	0.24	0.01	0.00
inline.JS	0.00	0.25	0.35	0.00	0.62	0.00	0.07	0.17	0.00	0.48	0.00	0.00
embed.CSS	0.00	0.05	0.71	0.03	0.00	0.00	0.54	0.51	0.47	0.32	0.01	0.00
inline.CSS	0.00	0.23	0.27	0.03	0.67	0.00	0.47	0.07	0.00	0.33	0.03	0.00
css.in.JS	0.35	0.44	0.63	0.00	0.85	0.00	0.70	0.47	0.00	0.23	0.39	0.63
css.in.JS.jquery	0.62	0.64	0.63	0.98	0.00	0.00	0.13	0.01	0.89	0.23	0.13	0.06
max.lines	0.38	0.77	0.07	0.00	0.12	0.00	0.56	0.04	0.00	0.85	0.07	0.07
max.lines.per.function	0.00	0.86	0.03	0.03	0.09	0.00	0.97	0.65	0.02	0.97	0.03	0.89
max.params	0.11	0.25	0.15	0.79	0.33	0.55	0.70	0.80	0.29	0.76	0.41	0.06
(Ex.)complexity	0.10	0.37	0.13	0.62	0.33	0.00	0.41	0.44	0.01	0.98	0.74	0.06
max.depth	0.20	0.88	0.24	0.00	0.00	0.65	0.58	0.27	0.04	0.22	0.11	0.06
max.nested.callbacks	0.07	0.00	0.02	0.99	0.00	0.00	0.54	0.12	0.00	0.61	0.06	0.14

5.1.2 Granger-causality lag1 (previous release)

Table 23: Granger causality lag1 between CS and TTR - p-values for all apps

CS\GClag1 p-value	phpMyAdmin	DokuWiki	OpenCart	phpBB	phpPgAdmin	MediaWiki	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Kanboard
(Ex.)CyclomaticComplexity	0.00	0.43	0.18	0.28	0.37	0.00	0.29	0.49	0.00	0.08	0.65	0.06
(Ex.)NPathComplexity	0.01	0.58	0.57	0.23	0.60	0.00	0.31	0.10	0.00	0.09	0.12	0.11
ExcessiveMethodLength	0.00	0.70	0.16	0.20	0.10	0.00	0.14	0.00	0.00	0.08	0.19	0.28
ExcessiveClassLength	0.00	0.71	0.83	0.41	0.09	0.00	0.35	0.00	0.00	0.06	0.22	0.49
ExcessiveParameterList	0.00	0.08	0.70	0.06	0.40	0.00	0.20	1.00	0.00	0.28	0.44	0.93
ExcessivePublicCount	0.00	0.62	0.84	0.94	0.29	0.05	0.19	0.51	0.56	0.06	0.14	1.00
TooManyFields	0.14	0.95	1.00	0.77	0.70	0.00	0.87	0.35	0.27	0.06	0.44	0.28
TooManyMethods	0.02	0.85	0.78	0.57	0.20	0.00	0.37	0.05	0.00	0.05	0.02	0.64
TooManyPublicMethods	0.00	0.39	0.88	0.88	0.69	0.81	0.15	0.25	0.01	0.08	0.03	1.00
ExcessiveClassComplexity	0.00	0.78	0.92	0.43	0.66	0.00	0.27	0.82	0.00	0.07	0.91	0.48
(Ex.)NumberOfChildren	0.00	0.62	0.14	0.80	0.91	0.00	1.00	0.54	0.01	1.00	0.06	0.36
(Ex.)DepthOfInheritance	1.00	1.00	1.00	1.00	0.16	1.00	0.81	1.00	1.00	1.00	0.55	1.00
(Ex.)CouplingBetweenObjects	0.01	0.36	0.08	0.91	0.10	0.00	0.22	0.89	0.04	0.10	0.05	0.16
DevelopmentCodeFragment	0.00	0.54	0.53	0.57	1.00	0.01	0.28	0.86	0.88	0.05	0.02	1.00
UnusedPrivateField	0.00	1.00	0.07	1.00	1.00	0.13	0.43	0.42	0.01	0.44	0.11	1.00
UnusedLocalVariable	0.00	0.27	0.09	0.46	0.53	0.00	0.25	0.56	0.00	0.53	0.87	0.51
UnusedPrivateMethod	0.00	1.00	0.30	0.09	1.00	0.00	0.15	0.24	0.00	0.28	0.01	0.47
UnusedFormalParameter	0.00	0.79	0.08	0.48	0.39	0.03	0.90	0.65	0.00	0.06	0.01	0.84
embed.JS	0.00	0.32	0.20	0.10	0.21	0.00	0.17	0.31	0.00	0.56	0.07	0.00
inline.JS	0.00	0.70	0.29	0.12	0.92	0.00	0.05	0.23	0.35	0.91	0.06	1.00
embed.CSS	0.00	0.00	0.81	0.24	0.36	0.00	1.00	0.17	0.85	0.68	0.10	0.10
inline.CSS	0.00	0.00	0.19	0.26	0.43	0.06	0.12	0.03	0.00	0.72	0.20	0.20
css.in.JS	0.22	0.33	0.85	0.23	0.92	0.00	0.54	0.93	0.00	0.43	0.30	0.81
css.in.JS..jquery	0.99	0.38	0.79	0.27	0.10	0.00	0.32	0.03	0.78	0.54	0.02	0.07
max.lines	0.20	0.58	0.06	0.20	0.04	0.02	0.65	0.05	0.00	0.76	0.01	0.12
max.lines.per.function	0.00	0.26	0.11	0.58	0.45	0.00	0.82	0.07	0.31	0.77	0.01	0.55
max.params	0.15	0.18	0.18	0.45	0.13	0.76	0.69	0.71	0.03	0.96	0.04	0.07
(Ex.)complexity	0.14	0.13	0.19	0.22	0.11	0.00	0.41	0.98	0.06	0.74	0.11	0.07
max.depth	0.30	0.21	0.27	0.29	0.86	0.75	0.32	0.37	0.55	0.49	0.99	0.07
max.nested.callbacks	0.08	0.72	0.10	0.22	1.00	0.00	0.50	0.15	0.00	0.98	0.03	0.16

5.1.3 Granger-causality lag2 (two releases before)

Table 24: Transfer entropy lag2 between CS and TTR - p-values for all apps

CS\GClag2 p-value	phpMyAdmin	DokuWiki	OpenCart	phpBB	phpPgAdmin	MediaWiki	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Kanboard
(Ex.)CyclomaticComplexity	0.50	0.65	0.29	0.23	0.69	0.00	0.52	0.45	0.00	0.27	0.82	0.22
(Ex.)NPathComplexity	0.65	0.53	0.40	0.27	0.83	0.00	0.45	0.12	0.00	0.38	0.34	0.22
ExcessiveMethodLength	0.15	0.69	0.11	0.26	0.14	0.00	0.51	0.00	0.00	0.27	0.22	0.33
ExcessiveClassLength	0.00	0.92	0.98	0.23	0.20	0.00	0.57	0.10	0.23	0.28	0.57	0.82
ExcessiveParameterList	0.54	0.33	0.87	0.16	0.53	0.00	0.73	1.00	0.00	0.54	0.25	0.99
ExcessivePublicCount	0.04	0.92	0.58	0.89	0.61	0.15	0.64	0.70	0.00	0.28	0.50	1.00
TooManyFields	0.41	0.71	1.00	0.15	0.89	0.00	0.42	0.82	0.00	0.22	0.88	0.60
TooManyMethods	0.42	0.78	0.55	0.56	0.43	0.00	0.78	0.03	0.00	0.25	0.10	0.68
TooManyPublicMethods	0.00	0.85	0.75	0.42	0.58	0.57	0.51	0.61	0.00	0.25	0.16	0.57
ExcessiveClassComplexity	0.01	0.82	0.91	0.20	0.37	0.00	0.40	0.86	0.00	0.22	1.00	0.80
(Ex.)NumberOfChildren	0.00	0.89	0.18	0.94	0.99	0.00	0.99	0.54	0.07	1.00	0.09	0.84
(Ex.)DepthOfInheritance	1.00	1.00	1.00	1.00	0.19	1.00	0.93	1.00	1.00	1.00	0.41	1.00
(Ex.)CouplingBetweenObjects	0.00	0.68	0.07	0.99	0.13	0.00	0.82	0.61	0.01	0.43	0.27	0.22
DevelopmentCodeFragment	0.10	0.41	0.65	0.83	1.00	0.01	0.39	0.24	0.01	0.26	0.12	1.00
UnusedPrivateField	0.40	1.00	0.10	1.00	1.00	0.01	0.90	0.17	0.04	0.58	0.22	1.00
UnusedLocalVariable	0.22	0.13	0.04	0.29	0.82	0.00	0.53	0.02	0.00	0.63	0.39	0.72
UnusedPrivateMethod	0.74	1.00	0.55	0.08	1.00	0.00	0.97	0.74	0.00	0.54	0.07	0.54
UnusedFormalParameter	0.19	0.86	0.05	0.68	0.50	0.05	0.32	0.79	0.00	0.20	0.05	0.39
embed.JS	0.18	0.29	0.28	0.26	0.48	0.04	0.93	0.06	0.00	0.82	0.27	0.00
inline.JS	0.12	0.67	0.49	0.31	0.90	0.01	0.64	0.75	0.52	0.71	0.26	1.00
embed.CSS	0.26	0.02	0.99	0.44	0.64	0.02	0.87	0.45	0.08	0.85	0.44	0.11
inline.CSS	0.33	0.00	0.37	0.53	0.05	0.25	0.90	0.23	0.00	0.71	0.17	0.35
css.in.JS	0.89	0.50	0.95	0.43	0.97	0.00	0.70	0.80	0.00	0.57	0.67	0.29
css.in.JS..jquery	0.75	0.43	0.92	0.27	0.12	0.00	0.56	0.20	0.98	0.69	0.12	0.06
max.lines	0.48	0.67	0.04	0.40	0.12	0.42	0.68	0.10	0.01	0.77	0.03	0.03
max.lines.per.function	0.15	0.31	0.12	0.29	0.19	0.00	0.90	0.03	0.38	0.88	0.06	0.08
max.params	0.97	0.46	0.21	0.07	0.35	0.94	0.92	0.78	0.65	0.99	0.03	0.02
(Ex.)complexity	0.97	0.33	0.26	0.11	0.26	0.00	0.88	0.89	0.14	0.94	0.09	0.02
max.depth	1.00	0.21	0.40	0.09	0.98	0.97	0.81	0.72	0.04	0.64	0.71	0.03
max.nested.callbacks	0.92	0.86	0.09	0.14	1.00	0.00	1.00	0.22	0.00	0.98	0.03	0.08

5.1.4 Transfer entropy lag1 (previous release)

Table 25: Transfer entropy lag1 between CS and TTR - p-values for all apps

CS\TElag1 p-value	phpMyAdmin	DokuWiki	OpenCart	phpBB	phpPgAdmin	MediaWiki	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Kanboard
(Ex.)CyclomaticComplexity	0.01	0.59	0.00	0.10	0.66	0.00	0.11	0.08	0.00	0.48	0.48	0.05
(Ex.)NPathComplexity	0.02	0.52	0.61	0.08	0.40	0.00	0.11	0.08	0.00	0.48	0.58	0.02
ExcessiveMethodLength	0.00	0.56	0.08	0.08	0.20	0.00	0.12	0.01	0.01	0.48	0.37	0.07
ExcessiveClassLength	0.01	0.78	0.17	0.10	0.00	0.00	0.18	0.14	0.00	0.09	0.38	0.00
ExcessiveParameterList	0.00	0.00	0.00	0.13	0.08	0.00	0.77	0.00	0.01	0.00	0.36	0.00
ExcessivePublicCount	0.08	0.23	0.52	0.00	0.49	0.10	0.18	0.25	0.01	0.00	0.36	0.00
TooManyFields	0.01	0.55	all cs=1	0.14	0.00	0.04	0.13	0.07	0.05	0.05	0.58	0.00
TooManyMethods	0.13	0.62		0.00	0.50	0.00	0.46	0.00	0.00	0.05	0.06	0.00
TooManyPublicMethods	0.00	0.24	0.01	0.34	0.00	0.00	0.01	0.11	0.22	0.25	0.70	0.16
ExcessiveClassComplexity	0.00	0.59	0.07	0.20	0.03	0.00	0.42	0.05	0.00	0.09	0.84	0.09
(Ex.)NumberOfChildren	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	all cs=1	0.08	0.09
(Ex.)DepthOfInheritance	0.00	0.00	0.00	0.00	0.38	0.00	0.08	0.00	0.00		0.00	0.00
(Ex.)CouplingBetweenObjects	0.25	0.00	0.00	0.01	0.00	0.00	0.02	0.26	0.00	0.25	0.18	0.14
DevelopmentCodeFragment	0.00	0.25	0.05	0.00	0.00	0.34	0.46	0.13	0.10	0.00	0.26	0.00
UnusedPrivateField	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.03	0.00	0.11	0.00
UnusedLocalVariable	0.09	0.41	0.21	0.11	0.75	0.00	0.14	0.10	0.00	0.09	0.67	0.01
UnusedPrivateMethod	0.00	0.00	0.01	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00
UnusedFormalParameter	0.71	0.11	0.00	0.37	0.00	0.46	0.94	0.15	0.00	0.01	0.00	0.01
embed.JS	0.08	0.57	0.00	0.14	0.23	0.03	0.11	0.01	0.00	0.42	0.09	0.06
inline.JS	0.00	0.55	0.00	0.21	0.05	0.00	0.02	0.03	0.03	0.56	0.21	0.00
embed.CSS	0.00	0.20	0.01	0.02	0.00	0.01	0.34	0.21	0.00	0.50	0.09	0.00
inline.CSS	0.00	0.23	0.01	0.04	0.10	0.00	0.00	0.00	0.00	0.56	0.55	0.00
css.in.JS	0.00	0.97	0.01	0.00	0.05	0.00	0.47	0.31	0.10	0.32	0.17	0.56
css.in.JS..jquery	0.00	0.48	0.22	0.00	0.00	0.00	0.66	0.00	0.59	0.50	0.25	0.08
max.lines	0.01	0.46	0.00	0.27	0.14	0.01	0.07	0.07	0.06	0.27	0.31	0.06
max.lines.per.function	0.50	0.23	0.60	0.32	0.45	0.00	0.13	0.10	0.41	0.46	0.21	0.01
max.params	0.00	0.25	0.00	0.07	0.06	0.05	0.05	0.17	0.58	0.05	0.13	0.03
(Ex.)complexity	0.00	0.25	0.06	0.01	0.16	0.00	0.05	0.17	0.42	0.29	0.17	0.08
max.depth	0.00	0.18	0.08	0.00	0.00	0.00	0.00	0.02	0.02	0.07	0.00	0.08
max.nested.callbacks	0.00	0.00	0.16	0.00	0.00	0.00	0.01	0.49	0.00	0.00	0.04	0.24

Table 26: Transfer entropy lag1 between CS and bugs - TE values(%) for all apps

CS\TElag1 TE	phpMyAdmin	DokuWiki	OpenCart	phpBB	phpPgAdmin	MediaWiki	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Kanboard
(Ex.)CyclomaticComplexity	7%	9%	53%	17%	21%	15%	13%	9%	21%	12%	17%	17%
(Ex.)NPathComplexity	7%	9%	21%	17%	24%	14%	13%	9%	31%	12%	17%	20%
ExcessiveMethodLength	20%	10%	38%	18%	28%	16%	13%	21%	15%	12%	21%	15%
ExcessiveClassLength	7%	7%	32%	14%	41%	22%	12%	13%	26%	24%	23%	0%
ExcessiveParameterList	8%	0%	58%	16%	30%	18%	7%	0%	15%	0%	20%	17%
ExcessivePublicCount	5%	12%	21%	25%	21%	9%	12%	12%	18%	0%	22%	0%
TooManyFields	7%	7%	100%	14%	0%	12%	13%	16%	17%	24%	15%	0%
TooManyMethods	7%	7%	21%	25%	25%	13%	10%	30%	35%	24%	11%	0%
TooManyPublicMethods	20%	12%	53%	12%	31%	15%	17%	15%	11%	16%	15%	11%
ExcessiveClassComplexity	9%	9%	42%	13%	42%	15%	8%	10%	24%	20%	11%	15%
(Ex.)NumberOfChildren	21%	0%	0%	24%	0%	21%	23%	14%	20%	100%	28%	15%
(Ex.)DepthOfInheritance	0%	0%	0%	0%	29%	0%	12%	0%	0%	0%	0%	0%
(Ex.)CouplingBetweenObjects	6%	0%	0%	24%	0%	26%	16%	11%	22%	16%	18%	15%
DevelopmentCodeFragment	21%	14%	41%	34%	0%	7%	8%	13%	12%	0%	26%	0%
UnusedPrivateField	8%	0%	54%	0%	0%	14%	17%	12%	15%	0%	22%	0%
UnusedLocalVariable	7%	11%	29%	18%	17%	15%	13%	16%	22%	20%	18%	22%
UnusedPrivateMethod	9%	0%	52%	0%	0%	14%	15%	22%	46%	0%	36%	0%
UnusedFormalParameter	4%	12%	59%	13%	31%	6%	4%	7%	30%	32%	29%	22%
embed.JS	8%	8%	40%	16%	37%	12%	14%	21%	25%	13%	30%	14%
inline.JS	13%	8%	57%	15%	37%	16%	17%	14%	14%	12%	23%	0%
embed.CSS	21%	15%	54%	17%	0%	11%	12%	12%	22%	11%	30%	22%
inline.CSS	12%	15%	51%	12%	30%	13%	20%	14%	26%	12%	19%	18%
css.in.JS	14%	5%	51%	18%	33%	16%	10%	11%	14%	12%	30%	10%
css.in.JS..jquery	8%	6%	32%	24%	0%	10%	8%	28%	7%	11%	22%	13%
max.lines	9%	10%	42%	11%	31%	12%	15%	16%	12%	16%	19%	15%
max.lines.per.function	5%	7%	18%	13%	20%	17%	13%	17%	9%	13%	23%	22%
max.params	21%	7%	44%	14%	35%	11%	17%	13%	6%	24%	23%	16%
(Ex.)complexity	15%	7%	40%	25%	29%	15%	17%	11%	7%	16%	24%	13%
max.depth	11%	16%	38%	0%	0%	12%	20%	19%	15%	25%	31%	13%
max.nested.callbacks	11%	0%	34%	24%	0%	14%	20%	10%	36%	19%	24%	11%

5.1.5 Transfer entropy lag2 (two releases before)

Next, the p-values and percentages for Transfer entropy of individual CS from two previous releases of software to "time-to-release", for the various applications.

Table 27: Transfer entropy lag2 between CS and TTR - p-values for all apps

CS\TElag2 p-value	phpMyAdmin	DokuWiki	OpenCart	phpBB	phpPgAdmin	MediaWiki	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Kanboard
(Ex.)CyclomaticComplexity	0.14	0.10	0.35	0.10	0.24	0.50	0.57	0.03	0.55	0.90	0.09	0.42
(Ex.)NPathComplexity	0.69	0.10	0.25	0.24	0.03	0.45	0.57	0.02	0.25	0.90	0.07	0.49
ExcessiveMethodLength	0.00	0.27	0.46	0.03	0.17	0.17	0.44	0.12	0.19	0.90	0.05	0.18
ExcessiveClassLength	0.03	0.22	0.16	0.48	0.18	0.02	0.41	0.30	0.14	0.32	0.29	0.00
ExcessiveParameterList	0.00	0.00	0.13	0.69	0.38	0.04	0.72	0.00	0.16	0.00	0.10	0.40
ExcessivePublicCount	0.14	0.19	0.65	0.20	0.04	0.83	0.12	0.21	0.14	0.00	0.57	0.00
TooManyFields	0.34	0.25	all cs=1	0.67	0.00	0.63	0.34	0.21	0.09	0.15	0.46	0.00
TooManyMethods	0.06	0.51		0.65	0.34	0.27	0.67	0.25	0.07	0.15	0.00	0.00
TooManyPublicMethods	0.01	0.13	0.44	0.87	0.00	0.45	0.15	0.29	0.19	0.14	0.18	0.06
ExcessiveClassComplexity	0.03	0.14	0.14	0.75	0.27	0.32	0.41	0.03	0.32	0.58	0.30	0.73
(Ex.)NumberOfChildren	0.91	0.00	0.00	0.85	0.00	0.00	0.13	0.60	0.32	all cs=1	0.40	0.54
(Ex.)DepthOfInheritance	0.00	0.00	0.00	0.00	0.81	0.00	0.61	0.00	0.00		0.00	0.00
(Ex.)CouplingBetweenObjects	0.75	0.00	0.00	0.94	0.00	0.00	0.70	0.78	0.32	0.14	0.01	0.36
DevelopmentCodeFragment	0.21	0.62	0.11	0.28	0.00	0.21	0.49	0.63	0.38	0.00	0.14	0.00
UnusedPrivateField	0.40	0.00	0.38	0.00	0.00	0.52	0.29	0.46	0.50	0.00	0.87	0.00
UnusedLocalVariable	0.26	0.50	0.25	0.15	0.13	0.16	0.49	0.36	0.09	0.58	0.42	0.55
UnusedPrivateMethod	0.12	0.00	0.00	0.00	0.00	0.27	0.70	0.14	0.00	0.00	0.33	0.00
UnusedFormalParameter	0.73	0.23	0.44	0.89	0.00	0.49	0.13	0.01	0.38	0.04	0.00	0.55
embed.JS	0.07	0.03	0.56	0.36	0.35	0.05	0.12	0.08	0.17	0.44	0.29	0.03
inline.JS	0.73	0.52	0.00	0.65	0.13	0.06	0.12	0.05	0.03	0.45	0.66	0.00
embed.CSS	0.52	0.19	0.59	0.01	0.00	0.48	0.71	0.56	0.91	0.47	0.29	0.05
inline.CSS	0.50	0.06	0.42	0.01	0.02	0.00	0.28	0.07	0.22	0.07	0.66	0.05
css.in.JS	0.92	0.07	0.35	0.00	0.04	0.07	0.36	0.15	0.34	0.63	0.41	0.55
css.in.JS.jquery	0.33	0.40	0.05	0.56	0.00	0.29	0.59	0.06	0.82	0.47	0.44	0.20
max.lines	0.82	0.89	0.00	0.71	0.05	0.03	0.55	0.55	0.61	0.01	0.68	0.55
max.lines.per.function	0.93	0.52	0.13	0.71	0.20	0.00	0.37	0.43	0.88	0.24	0.10	0.05
max.params	0.87	0.57	0.00	0.46	0.30	0.54	0.58	0.34	0.70	0.13	0.19	0.05
(Ex.)complexity	0.88	0.57	0.00	0.34	0.23	0.08	0.58	0.71	0.89	0.00	0.06	0.57
max.depth	0.02	0.10	0.46	0.00	0.00	0.05	0.50	0.21	0.40	0.00	0.00	0.57
max.nested.callbacks	0.16	0.00	0.39	0.58	0.00	0.00	0.41	0.59	0.05	0.00	0.02	0.86

Table 28: Transfer entropy lag2 between CS and TTR - TE values(%) for all apps

CS\TElag2 te	phpMyAdmin	DokuWiki	OpenCart	phpBB	phpPgAdmin	MediaWiki	PrestaShop	Vanilla	Dolibarr	Roundcube	OpenEMR	Kanboard
(Ex.)CyclomaticComplexity	11%	34%	40%	35%	66%	16%	18%	19%	20%	11%	60%	20%
(Ex.)NPathComplexity	7%	33%	70%	28%	74%	18%	18%	23%	21%	11%	67%	18%
ExcessiveMethodLength	8%	29%	49%	36%	51%	20%	20%	29%	23%	11%	61%	22%
ExcessiveClassLength	14%	28%	55%	20%	57%	20%	22%	26%	31%	26%	54%	0%
ExcessiveParameterList	13%	0%	59%	18%	46%	19%	18%	0%	19%	0%	61%	13%
ExcessivePublicCount	11%	22%	46%	28%	59%	13%	29%	27%	29%	0%	35%	0%
TooManyFields	8%	22%	100%	19%	0%	18%	22%	27%	31%	33%	41%	0%
TooManyMethods	19%	18%	46%	24%	53%	12%	27%	34%	32%	33%	48%	0%
TooManyPublicMethods	14%	21%	49%	14%	36%	16%	27%	25%	28%	34%	60%	27%
ExcessiveClassComplexity	12%	35%	57%	15%	59%	17%	18%	20%	20%	18%	51%	13%
(Ex.)NumberOfChildren	7%	0%	0%	18%	0%	22%	27%	20%	21%	100%	40%	13%
(Ex.)DepthOfInheritance	0%	0%	0%	0%	47%	0%	14%	0%	0%	0%	0%	0%
(Ex.)CouplingBetweenObjects	11%	0%	0%	19%	0%	22%	14%	14%	19%	34%	60%	18%
DevelopmentCodeFragment	4%	17%	58%	33%	0%	20%	18%	16%	19%	0%	62%	0%
UnusedPrivateField	10%	0%	49%	0%	0%	16%	13%	23%	21%	0%	30%	0%
UnusedLocalVariable	12%	22%	61%	35%	63%	21%	20%	26%	26%	18%	50%	16%
UnusedPrivateMethod	12%	0%	49%	0%	0%	10%	14%	23%	33%	0%	45%	0%
UnusedFormalParameter	10%	19%	55%	15%	39%	17%	25%	25%	23%	32%	39%	16%
embed.JS	18%	38%	28%	27%	58%	24%	26%	35%	19%	24%	51%	32%
inline.JS	10%	18%	40%	21%	61%	23%	26%	27%	24%	23%	37%	0%
embed.CSS	12%	27%	49%	31%	0%	12%	20%	16%	12%	23%	51%	23%
inline.CSS	12%	39%	49%	19%	66%	20%	19%	22%	21%	38%	42%	26%
css.in.JS	9%	41%	59%	18%	63%	21%	24%	26%	26%	15%	48%	21%
css.in.JS..jquery	8%	10%	66%	19%	0%	15%	21%	33%	13%	23%	39%	16%
max.lines	8%	11%	49%	18%	69%	18%	18%	19%	15%	46%	32%	14%
max.lines.per.function	8%	8%	65%	21%	65%	23%	24%	26%	13%	30%	55%	29%
max.params	8%	10%	40%	19%	51%	18%	19%	25%	16%	37%	44%	27%
(Ex.)complexity	8%	10%	49%	25%	58%	21%	19%	13%	12%	53%	54%	12%
max.depth	11%	33%	49%	0%	0%	18%	19%	25%	17%	36%	59%	12%
max.nested.callbacks	8%	0%	60%	18%	0%	22%	18%	20%	24%	31%	59%	15%

The values for lag 3 and 4, for all the studies, are the the replication package, available online.