APPENDIX A
UNIVARIATE LOGISTIC REGRESSION

Logistic regression is a widely adopted statistical modeling technique for modeling data with binary dependent variables. Suppose we have n independent variables ($X = \{X_1, X_2, ..., X_n\}$) and a dependent variable Y ($Y \in \{0, 1\}$) in our dataset. Logistic regression builds a model by training the dataset to estimate the probability value of $P(Y = 1|X_1, X_2, ..., X_n)$. The specific formula is as follows.

$$P(Y = 1|X_1, X_2, ..., X_n) = \frac{1}{1 + e^{-(\theta_0 + \theta_1 X_1 + \theta_2 X_3 + ... + \theta_n X_n)}}$$

Among them, θ_i represents the correlation coefficient in the logistic regression model, which can be calculated by the method of maximum likelihood estimation.

The univariate logistic regression method is a special case of logistic regression. The difference is that univariate logistic regression uses only one independent variable at a time to train the model. Therefore, for the univariate logistic regression model, it is calculated as follows.

$$P(Y = 1|X) = \frac{1}{1 + e^{-(\theta_0 + \theta_1 X)}}$$

APPENDIX B
CORRELATION ANALYSIS RESULTS

Here we present the experimental results of correlation analysis on each project for the other 3 hypotheses (**H2**, **H3**, and **H4**) of RQ2. The correlation analysis results on each project in Hypothesis **H2**, **H3** and **H4** are shown in table 11, 12, and 13, respectively.

APPENDIX C
CONFOUNDING EFFECT ANALYSIS METHOD

Here, we introduce the specific procedure of mixed effects analysis.

In order to obtain the real relationship between variables, there are two statistical methods (i.e., "controlling for confounding" and "removing the confounding") to eliminate the influence of confounding factors on the analysis results. In the literature [35], the "removing the confounding" method based on linear regression is recommended for eliminating the influence of confounding effect.

The specific process of the method is as follows. Suppose the independent variable is X, the dependent variable is Y, and the confounding factor is Z. We first construct a linear regression model ($X = a + bZ + \mu$) with X as the dependent variable and X as the independent variable, resulting in sample estimates of the intercept ($\hat{a}$) and coefficient ($\hat{b}$). Then, we can get the predicted value $\hat{X}$ of X by the linear regression ($\hat{X} = \hat{a} + \hat{b}Z$). Finally, we subtract the predicted value $\hat{X}$ from X to remove the confounding effect ($X' = X - \hat{X}$).

TABLE 11: The Correlation Results Between Software Dependencies and Blocked Bugs for **H2** on All Projects.

Project \ Dependency	Call↓	CallNondynamic↓	Couple↓	Create↓	DotRef↓	Extend↓	Implement↓	Import↓	Override↓	Typed↓	Use↓
4DIAC	**1.1675** (0.3287)	0.9595 (-0.0828)	**1.2281** (0.4438)	**1.217** (0.45)	**1.4171** (0.6973)	1.0662 (0.1297)	**1.2516** (0.6164)	**1.1864** (0.4067)	**1.1458** (0.2805)	**1.322** (0.561)	**1.4292** (0.7191)
Acceleo	**2.2843** (1.7031)	1.1625 (0.3045)	**2.7205** (2.1587)	**2.5182** (2.0651)	1.2545 (0.455)	0.9432 (-0.1205)	1.0916 (0.2362)	1.7005 (1.1137)	1.3275 (0.6142)	**2.4919** (1.8279)	0.8199 (-0.3995)
ACTF	**1.5364** (0.874)	**1.6612** (1.0381)	**1.56** (0.9224)	**1.312** (0.6146)	**1.9195** (1.3487)	**0.3699** (-2.0582)	0.9625 (-0.0912)	**1.3678** (0.6488)	0.8315 (-0.4077)	**1.5544** (0.8836)	**1.5123** (0.8981)
Ease	1.3586 (0.6393)	1.065 (0.1334)	1.1714 (0.3546)	1.0725 (0.1686)	**1.7882** (1.1641)	1.2627 (0.5034)	1.1079 (0.2614)	1.0874 (0.1762)	**1.3748** (0.6897)	1.088 (0.1686)	1.2374 (0.4493)
EclipseLink	**1.4386** (0.8201)	**1.8115** (1.195)	**1.2846** (0.644)	**1.6744** (1.0321)	**1.8439** (1.224)	1.0246 (0.0496)	**1.2418** (0.6634)	**1.7746** (1.211)	1.0696 (0.1345)	**1.6461** (1.0522)	**1.6934** (1.1114)
EMF	**2.0466** (1.5357)	**1.8181** (1.1955)	**1.8009** (1.3361)	1.1484 (0.287)	**1.8068** (1.196)	**0.4968** (-1.4222)	0.8815 (-0.2808)	**1.2616** (0.6211)	**0.7102** (-0.6849)	**1.618** (1.0435)	1.1049 (0.1997)
EMFStore	1.4424 (0.7556)	1.1415 (0.2647)	1.3912 (0.7036)	**1.5853** (1.0916)	**1.4685** (0.7718)	0.8333 (-0.3666)	1.2696 (0.5765)	1.1826 (0.3819)	1.1753 (0.3248)	**1.6662** (1.0277)	**1.65** (1.0141)
Jubula	1.7197 (1.1421)	**1.9854** (1.3726)	1.2237 (0.4922)	**2.2257** (1.7355)	**2.6121** (1.9433)	1.4711 (0.7803)	**1.5162** (1.0148)	1.8245 (1.3322)	**2.0435** (1.4432)	1.3367 (0.5883)	**2.0397** (1.439)
Mylyn	0.8794 (-0.2739)	0.9448 (-0.114)	**0.7189** (-0.7895)	**1.2515** (0.4634)	1.0836 (0.1609)	0.9764 (-0.0503)	0.9208 (-0.2653)	0.8798 (-0.2756)	0.9958 (-0.0088)	0.9364 (-0.1352)	1.1817 (0.3374)
Papyrus	**1.473** (0.7989)	**1.3991** (0.6718)	**1.4957** (0.8938)	**1.6858** (1.1604)	**1.7421** (1.126)	**1.3329** (0.5763)	0.9991 (-0.0023)	**1.4829** (0.8488)	**1.3849** (0.6577)	**1.2221** (0.407)	**1.5871** (0.9238)
Sirius	**2.1716** (1.7406)	**1.1519** (0.2837)	**2.0421** (1.6969)	**1.237** (0.471)	**1.9703** (1.4633)	**1.4364** (0.7269)	**0.9532** (-0.1246)	**2.1254** (1.9665)	**1.5717** (0.9054)	0.9961 (-0.0078)	**1.9348** (1.3652)
Virgo	**1.5915** (0.948)	0.9418 (-0.12)	**1.2991** (0.5641)	**1.4539** (0.7788)	**1.2785** (0.5117)	1.0576 (0.1412)	**1.3596** (0.7352)	**1.8549** (1.2703)	**1.3533** (0.6756)	**1.6822** (1.0429)	**1.1667** (0.3756)
JDT	**4.1261** (3.0549)	**3.1413** (2.5738)	**4.2405** (2.951)	**2.2527** (2.0952)	**3.4212** (2.8109)	**1.9487** (1.5566)	**1.3473** (1.1066)	**3.8065** (2.8897)	**2.2096** (1.9633)	**3.3187** (2.5705)	**3.0426** (2.6314)
Significance	9(9/0)	7(7/0)	10(9/1)	11(11/0)	11(11/0)	5(3/2)	6(5/1)	8(8/0)	8(7/1)	9(9/0)	9(9/0)

The gray background indicates that software dependencies are significantly associated with blocked bugs (i.e., $p\text{-}value < 0.05$). The values in the table represent the ΔOR on the software dependency and the correlation coefficient in the logistic regression model, respectively. The three values in that row Significance indicate how many projects the software dependency has a significant, positive, and negative correlation with blocked bugs, respectively.

TABLE 12: The Correlation Results Between Software Dependencies and Blocking Bugs in $\mathbf{H_3}$ on All Projects.

Project \ Dependency	Call↑	CallNondynamic↑	Couple↑	Create↑	DotRef↑	Extend↑	Implement↑	Import↑	Override↑	Typed↑	Use↑
4DIAC	**1.0506** (0.0005)	**0.0856** (-0.0407)	1.0204 (0.0018)	**0.7576** (-0.1202)	**1.1014** (0.0017)	1.0483 (0.0319)	1.053 (0.0981)	**1.0682** (0.0059)	**1.1514** (0.0146)	1.0076 (0.0005)	**1.1052** (0.0015)
Acceleo	**1.1201** (0.0011)	0.0226 (-0.0491)	**1.1633** (0.0199)	1.116 (0.0125)	1.0462 (0.0007)	1.0041 (0.0024)	0.9358 (-0.1311)	1.1215 (0.014)	**1.1977** (0.022)	1.0798 (0.0025)	1.0494 (0.0007)
ACTF	1.0227 (0.0008)	0.7881 (-0.011)	1.0642 (0.0099)	0.8838 (-0.0287)	1.0142 (0.0008)	1.0234 (0.0067)	**0.2064** (-1.1999)	0.9802 (-0.0029)	0.8907 (-0.017)	0.7197 (-0.0293)	0.9841 (-0.0008)
Ease	**1.2428** (0.0094)	1.0488 (0.0011)	**1.285** (0.0328)	1.0577 (0.0191)	1.0489 (0.0028)	1.011 (0.0053)	0.9728 (-0.0306)	**1.2537** (0.0361)	1.1376 (0.0231)	**1.2235** (0.0232)	0.9968 (-0.0002)
EclipseLink	**1.0771** (0.0002)	0.9978 (-0.0)	**1.1405** (0.0038)	**1.0609** (0.0013)	**1.0662** (0.0013)	**1.0347** (0.0034)	0.998 (-0.0013)	**1.1707** (0.0074)	**1.0345** (0.001)	**1.1077** (0.0014)	**1.0595** (0.0008)
EMF	**1.0999** (0.0005)	1.0083 (0.0001)	**1.0508** (0.0017)	0.9717 (-0.0011)	**1.0462** (0.0006)	**1.0528** (0.0055)	0.9822 (-0.0026)	**1.0583** (0.0012)	**1.0474** (0.0013)	**1.0496** (0.0004)	**1.0452** (0.0002)
EMFStore	**1.0847** (0.0008)	0.9279 (-0.001)	1.0455 (0.0018)	0.9434 (-0.0172)	1.0096 (0.0002)	0.9811 (-0.0011)	**0.3051** (-1.4754)	0.9578 (-0.0036)	0.978 (-0.0011)	0.8708 (-0.0034)	0.9723 (-0.0006)
Jubula	**1.1611** (0.0032)	1.0551 (0.0012)	**1.1494** (0.0076)	0.8861 (-0.0194)	1.0947 (0.0017)	1.0282 (0.0074)	0.1017 (-0.3395)	**1.1188** (0.0066)	1.0538 (0.004)	1.0016 (0.0001)	1.0635 (0.0013)
Mylyn	1.0588 (0.0007)	0.0983 (-0.0289)	1.0815 (0.0041)	1.0389 (0.0035)	1.0021 (0.0)	1.0392 (0.0153)	0.0 (-13.9845)	1.0459 (0.003)	1.0389 (0.0038)	1.0308 (0.0009)	1.0541 (0.0014)
Papyrus	**1.0122** (0.0001)	0.9422 (-0.0003)	**1.0939** (0.003)	**1.0353** (0.0019)	**1.0135** (0.0)	0.9851 (-0.003)	**0.1111** (-0.6554)	**1.0514** (0.0017)	**0.9016** (-0.0037)	**0.8245** (-0.0136)	**1.0129** (0.0)
Sirius	**1.0643** (0.0006)	**0.9443** (-0.0009)	**1.0463** (0.0024)	**1.024** (0.0031)	**1.0418** (0.0005)	**1.0228** (0.0031)	**0.5231** (-0.3965)	**1.0452** (0.002)	**1.0356** (0.0014)	1.0025 (0.0001)	**1.0559** (0.0004)
Virgo	0.9032 (-0.0019)	**0.0519** (-0.0409)	**0.7192** (-0.0253)	0.9824 (-0.0015)	**0.7205** (-0.0211)	1.0232 (0.0112)	0.9222 (-0.0511)	0.9406 (-0.0055)	1.012 (0.0019)	0.9596 (-0.0017)	0.9047 (-0.004)
JDT	**1.1067** (0.0004)	**1.0324** (0.0001)	**1.1456** (0.0058)	**1.0733** (0.0051)	**1.118** (0.0009)	**1.0708** (0.0235)	1.0066 (0.003)	**1.1319** (0.0061)	**1.0471** (0.0022)	**1.0883** (0.0007)	**1.0482** (0.0002)
Significance	10(10/0)	4(1/3)	9(8/1)	5(4/1)	7(6/1)	4(4/0)	4(0/4)	8(8/0)	7(6/1)	5(4/1)	6(6/0)

The gray background indicates that software dependencies are significantly associated with blocking bugs (i.e., $p\text{-}value < 0.05$). The values in the table represent the ΔOR on the software dependency and the correlation coefficient in the logistic regression model, respectively. The three values in that row Significance indicate how many projects the software dependency has a significant, positive, and negative correlation with blocking bugs, respectively.

TABLE 13: The Correlation Results Between Software Dependencies and Blocked Bugs in $\mathbf{H_4}$ on All Projects.

Project \ Dependency	Call$^{\downarrow}$	CallNondynamic$^{\downarrow}$	Couple$^{\downarrow}$	Create$^{\downarrow}$	DotRef$^{\downarrow}$	Extend$^{\downarrow}$	Implement$^{\downarrow}$	Import$^{\downarrow}$	Override$^{\downarrow}$	Typed$^{\downarrow}$	Use$^{\downarrow}$
4DIAC	**1.0913** (0.0013)	**0.1416** (-0.038)	**1.1383** (0.0203)	**1.1411** (0.04)	**1.2358** (0.0167)	1.0535 (0.0901)	**1.2145** (0.4925)	**1.3271** (0.0479)	**1.1297** (0.0152)	**1.2514** (0.0246)	**1.2282** (0.0119)
Acceleo	**1.1273** (0.0013)	0.0034 (-0.0768)	**1.2315** (0.0385)	**1.2067** (0.0273)	**1.2024** (0.0086)	1.1218 (0.1631)	1.0849 (0.2155)	**1.495** (0.0695)	**1.2105** (0.0306)	**1.1306** (0.0053)	1.0267 (0.0015)
ACTF	**1.2578** (0.0116)	0.9972 (-0.0001)	**1.13** (0.0205)	**1.1807** (0.0466)	**1.2297** (0.0189)	**0.0661** (-2.0079)	1.0743 (0.0843)	**1.2418** (0.0517)	1.0295 (0.0057)	**1.1513** (0.0187)	**1.2036** (0.0152)
Ease	**1.2424** (0.0126)	1.1149 (0.0029)	**1.3027** (0.052)	1.1344 (0.0526)	1.1351 (0.0127)	**1.2586** (0.2223)	1.2164 (0.4125)	**1.3335** (0.0859)	1.1696 (0.0387)	**1.2887** (0.0614)	1.1838 (0.0266)
EclipseLink	**1.1322** (0.001)	1.0148 (0.0001)	**1.1861** (0.0143)	**1.1337** (0.0086)	**1.1342** (0.0059)	1.0545 (0.0423)	**1.0991** (0.1749)	**1.2461** (0.0307)	**1.2024** (0.0284)	**1.1906** (0.0064)	**1.0782** (0.0026)
EMF	1.0424 (0.0005)	0.6735 (-0.0047)	1.0601 (0.007)	1.0236 (0.0029)	1.0488 (0.002)	**0.2247** (-0.8799)	0.8386 (-0.1261)	**1.2096** (0.0252)	0.9891 (-0.001)	1.0787 (0.0029)	0.996 (-0.0001)
EMFStore	1.0925 (0.0012)	0.8902 (-0.0018)	1.1391 (0.0118)	**1.3231** (0.101)	**1.1542** (0.006)	0.543 (-0.1518)	**1.1946** (0.3183)	**1.6538** (0.0764)	**1.3236** (0.0392)	**1.1268** (0.0051)	**1.2951** (0.0171)
Jubula	**1.2613** (0.0074)	1.0869 (0.0026)	**1.2946** (0.0247)	**1.0975** (0.0167)	**1.4118** (0.0189)	1.0598 (0.0399)	**1.2055** (0.1298)	**1.3864** (0.0407)	**1.2987** (0.0554)	1.1322 (0.012)	**1.3029** (0.0213)
Mylyn	**1.2045** (0.0043)	1.0341 (0.0006)	**1.3048** (0.0322)	**1.1158** (0.0193)	**1.1905** (0.0105)	1.0889 (0.0814)	1.0277 (0.0479)	**1.3815** (0.0618)	**1.1316** (0.0246)	**1.2745** (0.0221)	**1.1853** (0.0108)
Papyrus	**1.0452** (0.0007)	**0.8514** (-0.0013)	**1.172** (0.0106)	**1.0836** (0.0075)	**1.0655** (0.0005)	**1.0897** (0.1169)	1.0167 (0.0348)	**1.3248** (0.0336)	**1.0151** (0.0011)	**0.9287** (-0.0084)	**1.0503** (0.0004)
Sirius	**1.1026** (0.0026)	**0.8095** (-0.0058)	**1.221** (0.0284)	**1.1614** (0.037)	**1.1139** (0.0048)	**1.21** (0.281)	0.9808 (-0.0428)	**1.3747** (0.0402)	**1.1346** (0.0153)	**1.1871** (0.0149)	**1.0354** (0.0009)
Virgo	**1.148** (0.0062)	**0.659** (-0.0072)	**1.0796** (0.0152)	**1.1658** (0.0318)	**1.0582** (0.0065)	1.047 (0.0949)	**1.1797** (0.2599)	**1.3978** (0.0862)	**1.225** (0.0741)	**1.2005** (0.0208)	0.9724 (-0.0022)
JDT	**1.128** (0.0008)	**1.0338** (0.0002)	**1.5575** (0.0336)	**1.1744** (0.0122)	**1.3684** (0.0053)	**1.2867** (0.3151)	**1.2252** (0.4455)	**1.5462** (0.0618)	**1.1714** (0.0265)	**1.1376** (0.0021)	**1.1467** (0.0012)
Significance	11(11/0)	5(1/4)	11(11/0)	11(11/0)	11(11/0)	6(4/2)	6(6/0)	13(13/0)	10(10/0)	11(10/1)	9(9/0)

The gray background indicates that software dependencies are significantly associated with blocked bugs (i.e., $p\text{-}value < 0.05$). The values in the table represent the ΔOR on the software dependency and the correlation coefficient in the logistic regression model, respectively. The three values in that row Significance indicate how many projects the software dependency has a significant, positive, and negative correlation with blocked bugs, respectively.