When Private Information Settles the Bill:
Money and Privacy in Google's Market for Smartphone Applications

ONLINE APPENDIX*

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Abstract

This Online Appendix contains the supporting materials for the paper "When Private Information Settles the Bill: Money and Privacy in Google's Market for Smartphone Applications," in which we shed light on a money-for-privacy trade-off in the market for smartphone applications ("apps"). Developers offer their apps at lower prices in return for greater access to personal information, and consumers choose between low prices and more privacy. We provide evidence for this pattern using data from 300,000 apps obtained from the Google Play Store (formerly Android Market) in 2012 and 2014. Our findings show that the market's supply and demand sides both consider an app's ability to collect private information, measured by the apps's use of privacy–sensitive permissions: (1) cheaper apps use more privacy–sensitive permissions; (2) given price and functionality, demand is lower for apps with sensitive permissions; (3) the strength of this relationship depends on contextual factors, such as the targeted user group, the apps's previous success and its category. Our results are robust and consistent across several robustness checks, including the use of panel data, a difference-in-differences analysis, the use of "twin" pairs of apps, or the use of various measures of privacy-sensitivity and app demand.

JEL Classification: D12, D22, L15, L86

Keywords: Android; Mobile Applications; Privacy; Permissions; Supply and Demand for Private Information.

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1 Online Appendix A - Supporting Materials

1.1 Additional Tables and Graphs

Figure A1: App Information in the Android Market 2012

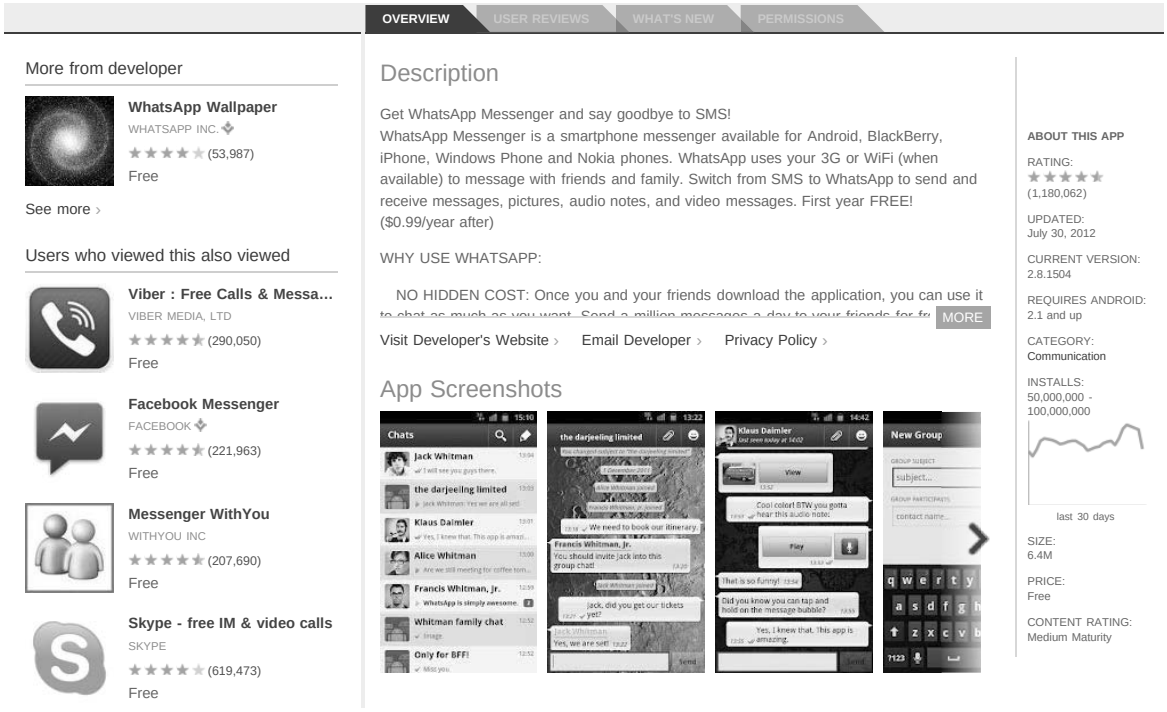


Figure A2: Permission Information in the Android Market 2012

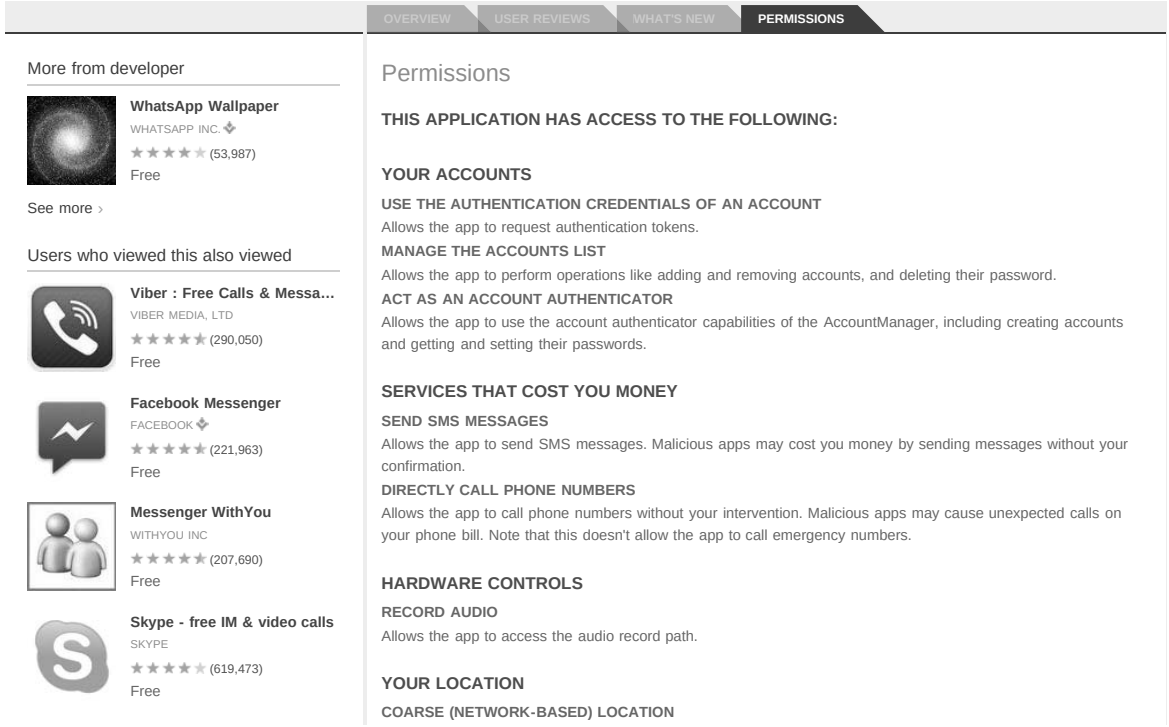


Table A1: Permission Definitions

Permissions (Group)	Description (provided by Google)
$D_{Privacy}$	
D_{ID}	
READ_PHONE_STATE	Allows an app to the read phone status and identity.
$D_{Location}$	
ACCESS_COARSE_LOCATION	Allows an app to access approximate location derived from network location sources such as cell towers and Wi-Fi.
ACCESS_FINE_LOCATION	Allows an app to access precise location from location sources such as GPS, cell towers, and Wi-Fi.
ACCESS_LOCATION_EXTRA_COMMANDS	Allows an apps to access extra location provider commands.
NFC	Allows apps to control Near Field Communication.
$D_{Communication}$	
INTERCEPT_OUTGOING_CALLS	Allows an app to see the number being dialed during an outgoing call with the option to redirect the call to a different number or abort the call altogether.
READ_SMS	Allows an app to read SMS and MMS messages.
RECEIVE_SMS	Allows an app to monitor incoming SMS messages, to record or perform processing on them.
RECEIVE_MMS	Allows an app to monitor incoming MMS messages, to record or perform processing on them.
RECORD_AUDIO	Allows an app to record audio.
RECEIVE_WAP_PUSH	Allows an app to monitor incoming WAP push messages.
$D_{Profile}$	
READ_CONTACTS	Allows an app to read the user's contacts data.
READ_HISTORY_BOOKMARKS	Allows an app to read (but not write) the user's browsing history and bookmarks.
READ_LOGS	Allows an app to read the low-level system log files.
GOOGLE_AUTH	Allows apps to see the usernames (email addresses) of the Google account(s) you have configured.
ACCOUNT_MANAGER	Allows an app to act as an AccountAuthenticator for the AccountManager.
MANAGE_ACCOUNTS	Allows an app to manage the list of accounts in the AccountManager.
GET_ACCOUNTS	Allows access to the list of accounts in the Accounts Service.
USE_CREDENTIALS	Allows an app to request auth tokens from the AccountManager.
READ_SYNC_STATS	Allows applications to read the sync stats.
SUBSCRIBED_FEEDS_READ	Allows an app to allow access the subscribed feeds ContentProvider.
CAMERA	Allows an app to take pictures and videos.
ACCESS_DOWNLOAD_MANAGER	Allows an app to access the download manager and to use it to download files.
READ_INPUT_STATE	Allows an app to record what you type and actions that you take.
MOUNT_UNMOUNT_FILESYSTEMS	Allows mounting and unmounting file systems for removable storage.
$D_{Internet}$	
INTERNET	Allows apps to open network sockets.
D_{Ads}	
ACCESS_NETWORK_STATE	Allows apps to access information about networks.

Source: `http://developer.android.com/reference/android/Manifest.permission.html` and `https://android.izzysoft.de/applists/perms?lang=en`.

Table A2: List of Variables

Variable	Description
ΔRatings	Monthly change in the number of ratings
ΔInstallations	Monthly change in the number of installations
Ratings	Number of ratings
Installations	Number of installations
ΔR_{AprSep}	Change in the number of ratings between April and September 2012
ΔR_{1214}	Change in the number of ratings between 2012 and 2014
ΔI_{Apr}	Change in the number of installations in April 2012
ΔI_{AprSep}	Change in the number of installations between April and September 2012
ΔI_{1214}	Change in the number of installations between 2012 and 2014
$\Delta Rank^{iOS-And}$	Aggregated difference of app i's iOS and Android rankings ($iOSAppStoreRank_i - AndroidRank_i$)
Price	Price of apps (in Euro)
D_{Paid}	Dummy equal to one if price > 0
$\#_{TotalPerm}$	Number of total permissions
$D_{Privacy}$	Dummy equal to one if an app uses at least one of the 25 privacy-sensitive permissions from the groups D_{ID}, $D_{Location}$, $D_{Communication}$ or $D_{Profile}$ as defined by Table A1
$\#Privacy$	Number of privacy-sensitive permissions
$\#CleanPerm$	Number of unproblematic permissions (i.e. $\#_{TotalPerm} - \#Privacy$).
$D_{Sarmaetal}$	Dummy equal to one if the app uses at least one of the permissions classified as privacy-sensitive by Sarma et. al (2012), i.e. if it uses at least one of ACCESS_COARSE_LOCATION, ACCESS_FINE_LOCATION, INTERCEPT_OUTGOING_CALLS, READ_CONTACTS, READ_HISTORY_BOOKMARKS, READ_SMS, RECEIVE_SMS, RECEIVE_MMS, RECORD_AUDIO, RECEIVE_WAP_PUSH, READ_LOGS or READ_PHONE_STATE
D_{Google}	Dummy equal to one if the app uses at least one 'potentially malicious' permission (as classified and indicated by Google), i.e. if it uses at least one of the following permissions: sendsmsmessages, accessdownloadmanager, interceptoutgoingcalls, addormodifycalendareventsandsend, sendsmsreceivedbroadcast, accessextralocationprovidercomma, deleteapplications, sendwappushreceivedbroadcast, enableapplicationdebugging, retrievesysteminternalstate, readsmsormms, directlycallanyphonenumbers, permissiontoinstallalocationprov, writebrowser39shistoryandbookmar, finegpslocation, receivemms, mocklocationsourcesfortesting, receivewap, editsmsormms, monitorandcontrolallapplicationl, receivedatafrominternet, directlyinstallapplications, presskeysandcontrolbuttons, sendstickybroadcast, readcontactdata, displaysystemlevelalerts, modifyglobalsystemsettings, retrieverunningapplications, readcalendarevents, enableordisableapplicationcompon, setpreferredapplications, reorderrunningapplications, receivesms, directlycallphonenumbers, writecontactdata, writesubscribedfeeds
$D_{PrivCatSpec}$	Dummy equal to one if an app uses at least one category-specific privacy-sensitive permission. We flag a privacy-sensitive permission as problematic within a app category if paid apps of this category use this permission on average less often than the overall average paid app (for more details see section 1.3)

Continued on next page

Table A2 – continued from previous page

Variable	Description
$D_{MTurkEP2}$	Dummy equal to one if the app uses at least one of the privacy-sensitive permissions classified as extremely problematic by Amazon MTurk survey participants, i.e. if it uses at least one of READ_SMS, RECORD_AUDIO, INTERCEPT_OUTGOING_CALLS, READ_LOGS
D_{PGrade}	Dummy equal to one if the app got a bad rating equal to 'B', 'C' or 'D' from Lin et al. (2014.) (published on privacygrade.org in 2014), i.e. if it got a rating indicating the app is privacy-intrusive
Average rating	Average of the ratings the app has received so far (between 1 and 5 stars)
AR_{Apr}	Average of the ratings the app has received in April 2012
AR_{AprSep}	Average of the ratings the app has received between April and September 2012
Size	Code size of the app (in KB)
App description	Length of the app description (in number of characters)
Number of screenshots	Number of screenshots available in the app description
Video	Dummy equal to one if a video is available in the app description
Top developer (D_{TopDev})	Dummy equal to one if the app is provided by a top developer (measured by a badge, awarded by Google)
Apps by developer ($AppByDev$)	Number of available apps of the developer
Average installations of developer	Average number of installations of the developer's other apps
$ShareDev_{Privacy}$	Share of other apps by developer which use at least on privacy-sensitive permission
Average price of competitors	Average price of competitor apps
Average installations of competitors	Average installations of competitor apps
Average rating of competitors	Average rating of competitor apps
$ShareComp_{Privacy}$	Share of competitor apps which use at least one privacy-sensitive permission
App category	Categorical variable indicating apps' category
Maturity level	Categorical variable indicating the recommended necessary maturity level of app users ('everyone', 'low maturity', 'medium maturity', 'high maturity', 'not rated')
$D_{Maturity}$	Dummy equal to one if the app requires medium or high maturity or is not rated
App version	Version number of app
Minimum Android version	Minimum compatible Android OS version
Maximum Android version	Maximum compatible Android OS version
$D_{NumInst}$	Dummy equal to one if the app has accumulated 10000 or more installations since its market entry
D_{Transp}	Dummy equal to one if the app has published a privacy policy, email and website address that are directly accessible from the Play Store
$D_{AlexaRank}$	Dummy equal to one if the app has a high ranking on Alexa.com, i.e. its website traffic rank is lower than 10000
D_{Game}	Dummy equal to one if the app is a game
$D_{MedHealth}$	Dummy equal to one if the app is a health or medical app

Table A3: Summary Statistics - Cross-Section April 2012

	mean	sd	min	p10	p50	p90	max
Outcome Measures:							
ΔRatings	7.35	29.78	0	0	0	12	403
ΔInstallations	2340	64892	0	0	0	0	22500000
Ratings	127.47	1026.34	1	1	7	142	160404
Installations	32085	2.1e+05	3	30	3000	30000	30000000
Price	0.55	2.41	0	0	0	1	136
Permissions:							
$\#_{TotalPerm}$	3.62	3.77	0	0	3	9	114
$D_{Privacy}$	0.44	0.50	0	0	0	1	1
$\#_{Privacy}$	1.00	1.56	0	0	0	3	23
$\#_{CleanPerm}$	2.61	2.57	0	0	2	6	92
$D_{PrivCatSpec}$	0.19	0.39	0	0	0	1	1
$D_{MTurkEP2}$	0.11	0.31	0	0	0	1	1
D_{Google}	0.30	0.46	0	0	0	1	1
$D_{Sarmaetal}$	0.41	0.49	0	0	0	1	1
D_{ID}	0.27	0.45	0	0	0	1	1
$D_{Location}$	0.24	0.43	0	0	0	1	1
$D_{Communication}$	0.06	0.24	0	0	0	0	1
$D_{Profile}$	0.18	0.39	0	0	0	1	1
$D_{Internet}$	0.71	0.45	0	0	1	1	1
D_{Ads}	0.46	0.50	0	0	0	1	1
Control Variables:							
Average Rating	3.93	0.97	1	3	4	5	5
Size (in KB)	2665	5809	4	76	852	6500	461000
Length Description	803	791	7	172	509	1837	12285
Number Screenshots	3.45	1.89	0	2	3	6	8
Dummy: Video	0.10	0.31	0	0	0	1	1
Dummy: Top-Developer	0.01	0.07	0	0	0	0	1
Apps by Developer	101	388	1	1	6	186	3548
Average Installations of Developer	69998	6.8e+05	0	210	8157	130178	75000000
Observations	177193						

Notes: The table provides summary statistics for our estimation sample based on the cross-section from April 2012. The discrepancy between our sample and the full app population of around 300,000 apps is mainly due to excluding apps which (a) were not available in some of the subsequent monthly waves we use for our panel analysis, (b) apps which lack relevant variables, (c) apps which have a stock of zero installations or ratings as well as (d) outliers with respect to our main demand measure.

Table A4: Alternative Supply Side Results

	Privacy Measures				Non-Games vs Games		Moderating Factors		App Pairs	
D_{Paid}	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\#_{Privacy=1}$	-0.010***									
	(0.003)									
$\#_{Privacy=2}$	-0.058***									
	(0.003)									
$\#_{Privacy\geq 3}$	-0.111***									
	(0.004)									
$D_{Privacy}$		0.012*			-0.012***	-0.057***	-0.062***	-0.037***	-0.246***	
		(0.006)			(0.003)	(0.005)	(0.003)	(0.003)	(0.054)	
$D_{Privacy} \times D_{Internet}$		-0.055***								
		(0.007)								
$D_{PrivCatSpec}$			-0.102***							
			(0.003)							
$\#_{PrivCatSpec}$				-0.045***						
				(0.001)						
$D_{Privacy} \times D_{NumInst}$							0.144***			
							(0.003)			
$D_{NumInst}$							-0.322***			
							(0.003)			
$D_{Privacy} \times D_{AlexaRank}$								0.046**		
								(0.018)		
$D_{AlexaRank}$								-0.109***		
								(0.016)		
$\#_{Privacy}$										-0.199***
										(0.029)
$\#_{CleanPerm}$	0.009***	0.005***	0.006***	0.008***	0.003***	0.012***	0.005***	0.004***	0.031	0.051**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.024)	(0.025)
$D_{Internet}$	-0.223***	-0.209***	-0.216***	-0.220***	-0.206***	-0.221***	-0.209***	-0.217***	-0.392***	-0.422***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.008)	(0.003)	(0.003)	(0.047)	(0.047)
D_{Ads}	-0.122***	-0.117***	-0.120***	-0.120***	-0.127***	-0.139***	-0.106***	-0.114***	-0.522***	-0.531***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.006)	(0.002)	(0.003)	(0.051)	(0.048)
Constant	0.081**	0.085**	0.080**	0.087**	-0.067*	0.087	0.127***	0.133***	-0.411	-0.167
	(0.035)	(0.035)	(0.035)	(0.035)	(0.040)	(0.088)	(0.034)	(0.039)	(0.687)	(0.667)
Category	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	176000	176000	176000	176000	145972	30028	176000	145126	708	708
Num. of Groups									354	354
Mean of dep. Var.	0.27	0.27	0.27	0.27	0.28	0.23	0.27	0.27	0.50	0.50
SD of dep. Var.	0.44	0.44	0.44	0.44	0.45	0.42	0.44	0.44	0.50	0.50
Adjusted R^2	0.323	0.320	0.324	0.324	0.348	0.260	0.367	0.319	0.848	0.862

NOTES: The table shows additional supply-side results for the developer's choice of their business model. The dependent variable is the developer's decision to offer their app for money or for free (D_{Paid}). Column 1 uses as privacy measure an individual dummy for each number of privacy-sensitive permissions (1, 2 or 3 and more permissions). Column 2 uses a cross term equal to one for apps which simultaneously use sensitive permissions and have access to the internet. Columns 3 and 4 use our category-specfic privacy measures. Within a category we flag a privacy-sensitive permission as problematic only if paid apps of this category use this permission on average less often than the overall average paid app. Columns 5 and 6 split the sample into normal apps (Col. 5) and games (Col. 6). Column 7 adds a cross term for apps with a very large total number of installations (10000 or more). Column 8 adds a cross term for apps that could be associated with a top-ranked website (on Alexa.com), i.e. for a website with rank lower than 10000. Columns 9 and 10 analyze the most restrictive set of matched pairs (no difference in description or only difference describes existence of ads, verified by human coders). In all specifications we drop outliers with respect to app prices, i.e. apps with prices above 8 Euros. All of these regressions control for the number of clean permissions and permissions that are needed to show ads. Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table A5: Alternative Panel Demand Side Estimation Results

Log. $\Delta Ratings$	(1)	(2)	(3)	(4)	(5)	(6)
$D_{Privacy}$	-0.070***	-0.059***	-0.063**			
	(0.020)	(0.020)	(0.027)			
$\#_{Privacy}$				-0.023***	-0.014**	-0.010
				(0.006)	(0.007)	(0.009)
$\#_{CleanPerm}$	-0.010**	-0.010**	-0.003	-0.000	-0.005	-0.001
	(0.004)	(0.005)	(0.006)	(0.005)	(0.005)	(0.007)
$D_{Internet}$	-0.003	0.003	0.033	-0.021	-0.014	0.012
	(0.054)	(0.054)	(0.072)	(0.054)	(0.053)	(0.071)
D_{Ads}	0.007	0.002	-0.041	-0.011	-0.014	-0.058
	(0.033)	(0.033)	(0.043)	(0.032)	(0.033)	(0.043)
Log. Price	-0.044***	-0.044***	-0.037***	-0.044***	-0.043***	-0.037***
	(0.011)	(0.011)	(0.013)	(0.011)	(0.011)	(0.013)
Constant	1.158***	1.198**	0.749***	1.156***	1.201**	0.741***
	(0.127)	(0.561)	(0.154)	(0.128)	(0.563)	(0.155)
Category	No	Yes	No	No	Yes	No
Month	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	No	No	Yes	No
Observations	33095	33095	15220	33095	33095	15220
Num. of Groups	6619	6619	3044	6619	6619	3044
Mean of dep. Var.	1.63	1.63	1.17	1.63	1.63	1.17
SD of dep. Var.	2.23	2.23	2.10	2.23	2.23	2.10
Adjusted R^2	0.026	0.033	0.020	0.026	0.033	0.020

NOTES: This table shows the results from fixed-effect panel regressions. The dependent variable is the log. number of monthly new ratings of an app. We restrict our sample to apps within our data set that varied their use of privacy-sensitive permissions at least once between April and September 2012. Columns 1-3 analyze the effect of introducing any privacy-sensitive permissions (measured by the indicator $D_{Privacy}$), whereas Columns 4-6 use the number of privacy-sensitive permissions as the variable of interest. Columns 1 and 4 show the raw fixed effects regressions without controls. In Columns 2 and 5 we add control variables and dummies to control for the apps' categories. Columns 3 and 6 restrict the analysis to apps that introduced new permissions without changing the app's description (no change in the length of description). In all specifications we include monthly fixed-effects and control for the number of unproblematic permissions. Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table A6: Alternative Difference-in-Differences-Style Estimation Results:

	Global Ranks		US Ranks		Non-Games vs Games	
	(1)	(2)	(3)	(4)	(5)	(6)
$D_{Privacy}$	-116.468***	-12.660**	-182.504***	-14.988**	-25.368**	1.533
	(35.327)	(6.088)	(58.130)	(6.321)	(10.316)	(8.488)
$\#_{CleanPerm}$	0.266	0.849	0.344	1.011*	1.498**	-1.310
	(3.473)	(0.598)	(5.476)	(0.595)	(0.694)	(1.263)
Constant	264.070***	4.262	320.040***	2.428	10.214	6.258
	(29.120)	(5.018)	(48.089)	(5.229)	(9.514)	(6.209)
Observations	192	192	162	162	96	96
Mean of dep. Var.	175.94	-0.24	176.85	-3.22	-1.07	0.59
SD of dep. Var.	188.76	31.81	274.05	29.27	32.96	30.78
Adjusted R^2	0.056	0.013	0.059	0.025	0.062	-0.006

Notes: This table shows further demand side results from comparing the download ranks of an app in the iOS Appstore and Google's Play Store depending on whether it's Android version uses privacy-sensitive permissions or not. The dependent variable captures differences in the ranks on the two platforms (iOS App Store ranks minus Google Play Store ranks). Colums 1, 2, 5 and 6 compare the apps' average ranks of the seven countries we collected ranks for, whereas Columns 3 & 4 use only the US ranks. Columns 1 & 3 use as dependent variable the difference between the simple rank averages whereas Columns 2 & 4 use as the dependent variable the difference between the newly created ranks within the operating system, which are based on the average download ranks we observed on AppAnnie.com. Columns 5 & 6 also use the difference between the newly created ranks based on the average download ranks but contrast games (Column 6) with other apps (Column 5). Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table A7: Alternative Moderating Factors

	Top-Developer		Alexa Rank		Games		Pricing Model	
Log. $\Delta Ratings$	No	Yes	No	Yes	No	Yes	Free	Paid
$D_{Privacy}$	-0.065***	0.088	-0.055***	0.010	-0.082***	-0.020	-0.026**	-0.121***
	(0.009)	(0.151)	(0.010)	(0.172)	(0.010)	(0.022)	(0.011)	(0.014)
$\#_{CleanPerm}$	0.036***	0.097***	0.035***	0.051*	0.037***	0.098***	0.037***	0.054***
	(0.003)	(0.031)	(0.003)	(0.028)	(0.003)	(0.009)	(0.003)	(0.006)
$D_{Internet}$	-0.195***	0.023	-0.187***	0.152	-0.211***	-0.201***	-0.256***	-0.075***
	(0.009)	(0.231)	(0.010)	(0.264)	(0.010)	(0.024)	(0.012)	(0.013)
D_{Ads}	0.232***	0.360**	0.226***	-0.251	0.228***	0.157***	0.241***	0.039**
	(0.009)	(0.164)	(0.010)	(0.173)	(0.010)	(0.024)	(0.010)	(0.017)
Log. Price	-0.071***	-0.108***	-0.071***	-0.107***	-0.068***	-0.095***	0.000	0.099***
	(0.001)	(0.011)	(0.001)	(0.024)	(0.001)	(0.002)	(.)	(0.007)
Constant	-3.852***	-3.587*	-3.832***	-6.650***	-3.398***	-5.120***	-3.557***	-3.416***
	(0.123)	(2.124)	(0.136)	(2.355)	(0.140)	(0.306)	(0.152)	(0.172)
Category	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	176224	969	145367	771	147143	30050	128921	48272
Mean of dep. Var.	0.09	2.15	0.11	2.19	0.07	0.26	0.33	-0.50
SD of dep. Var.	1.54	2.25	1.55	2.09	1.52	1.70	1.65	1.06
Adjusted R^2	0.286	0.538	0.298	0.348	0.280	0.370	0.285	0.262

Notes: The table shows the relationship between the presence of privacy-sensitive permissions and app demand for subsamples of our data. App demand is measured by the log. number of monthly new ratings of an app. Columns 1 and 2 split the sample into apps which are from a top developer (according to Google's classification) or not. Columns 3 and 4 split the sample into normal apps and games. Columns 5 and 6 split them into normal apps and games. Columns 7 and 8 split the sample into free and paid apps. All specifications control for the number of unproblematic permissions ($\#CleanPerm.$). Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table A8: Alternative Demand Measures

	Ratings-Based		Installations-Based			Predicted New Installations			Average Rating	
	ΔR_{AprSep}	ΔR_{1214}	ΔI_{Apr}	ΔI_{AprSep}	ΔI_{1214}	param.	param. 1214	non-param.	AR_{Apr}	AR_{AprSep}
$D_{Privacy}$	-0.093***	-0.070***	-0.054***	-0.197***	-0.388***	-0.030***	-0.053***	-0.183***	-0.022***	-0.018***
	(0.011)	(0.015)	(0.016)	(0.025)	(0.036)	(0.004)	(0.007)	(0.024)	(0.003)	(0.003)
$\#_{CleanPerm}$	0.042***	0.035***	0.010***	0.014**	-0.010	0.017***	0.030***	0.069***	0.000	0.000
	(0.003)	(0.004)	(0.004)	(0.006)	(0.008)	(0.001)	(0.002)	(0.006)	(0.001)	(0.001)
$D_{Internet}$	-0.220***	-0.250***	-0.078***	-0.206***	-0.317***	-0.092***	-0.163***	-0.416***	-0.054***	-0.056***
	(0.012)	(0.016)	(0.015)	(0.025)	(0.037)	(0.004)	(0.007)	(0.026)	(0.004)	(0.004)
D_{Ads}	0.326***	0.356***	0.248***	0.618***	0.925***	0.109***	0.192***	0.613***	0.009**	0.014***
	(0.011)	(0.016)	(0.015)	(0.024)	(0.037)	(0.004)	(0.007)	(0.025)	(0.004)	(0.003)
Log. Price	-0.114***	-0.173***	-0.038***	-0.113***	-0.307***	-0.033***	-0.058***	-0.201***	-0.002***	-0.005***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)	(0.000)	(0.001)	(0.002)	(0.000)	(0.000)
Constant	-4.583***	-5.540***	-3.557***	-6.936***	-13.206***	-2.248***	-3.083***	-6.608***	0.354***	0.360***
	(0.156)	(0.229)	(0.196)	(0.324)	(0.505)	(0.056)	(0.100)	(0.345)	(0.055)	(0.046)
Category	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	176212	124482	177193	177193	126987	177193	177193	177193	68248	102594
Mean of dep. Var.	0.97	2.40	-0.42	0.86	4.63	-0.42	0.16	2.76	1.29	1.29
SD of dep. Var.	2.03	2.52	2.34	3.89	5.16	0.72	1.27	4.25	0.35	0.35
Adjusted R^2	0.360	0.388	0.037	0.086	0.201	0.294	0.294	0.272	0.043	0.052

Notes: The table shows descriptive regressions analyzing the relationship between privacy-sensitive permissions and app demand by using various different demand and app popularity measures. Columns 1 and 2 use alternative demand measures based on ratings, Columns 3-5 use demand measures based on installations, whereas Columns 6-8 use three measures of predicted new installations which we estimated based on the information about the number of new ratings. Columns 9 and 10 use the average ratings of apps as a measure of app popularity. In Column 1 (2) the dependent variable is the log. number of new ratings between April and September 2012 (log. number of new ratings between 2012 and 2014). In Column 3 the dependent variable is the log. number of new installations in April 2012. Columns 4 and 5 use the log. number of new installations between April and September 2012 (Column 4) and between 2012 and 2014 (Column 5) as demand measures. In Columns 6-8 we apply three measures of predicted download numbers. For each of the measures we exploit the cross-section information on changes in ratings to predict changes in installation numbers. In Column 6, we use a measure of predicted monthly installation changes in April 2012 which is based on the observed change in the number of ratings in this month (see Column 2 of Table A12). In Column 7, we use a measure of predicted installation changes between April and September 2012 which is based on the observed change in the number of ratings in this period (see Column 4 of Table A12). In Column 8, we again use a measure of predicted monthly installation changes in April 2012 which is based on the observed change in the number of ratings in this month (see Column 2 of Table A12), but instead of employing a parametric log-log-specification to the data, we employ a non-parametric approach to it. In Columns 9 the dependent variable is the log. average of the ratings the app has received in April 2012, whereas in Column 10 it is the log. average of the ratings the app has received between April and September 2012. Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table A9: Alternative Privacy Measures

Log. $\Delta Ratings$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\#_{Privacy=1}$	-0.054***							
	(0.010)							
$\#_{Privacy=2}$	-0.087***							
	(0.014)							
$\#_{Privacy\geq 3}$	-0.089***							
	(0.014)							
$D_{Privacy}$		-0.060***	-0.048***	-0.040***		-0.086***		
		(0.009)	(0.010)	(0.014)		(0.018)		
$D_{MTurkEP2}$		-0.021*						
		(0.013)						
$D_{PrivCatSpec}$			-0.048***					
			(0.012)					
D_{PGrade}				0.148***				
				(0.020)				
$D_{Privacy} \times D_{Internet}$					-0.057***	0.025		
					(0.010)	(0.019)		
D_{ID}							0.046***	
							(0.009)	
$D_{Location}$							-0.200***	
							(0.014)	
$D_{Communication}$							-0.015	
							(0.016)	
$D_{Profile}$							-0.034***	
							(0.011)	
$D_{Sarmaetal}$								-0.048***
								(0.009)
$\#_{CleanPerm}$	0.038***	0.037***	0.037***	0.048***	0.036***	0.037***	0.038***	0.036***
	(0.003)	(0.003)	(0.003)	(0.005)	(0.003)	(0.003)	(0.003)	(0.003)
$D_{Internet}$	-0.202***	-0.201***	-0.199***	-0.288***	-0.192***	-0.204***	-0.201***	-0.202***
	(0.009)	(0.009)	(0.009)	(0.015)	(0.009)	(0.010)	(0.009)	(0.009)
D_{Ads}	0.234***	0.234***	0.235***	0.260***	0.236***	0.235***	0.219***	0.235***
	(0.009)	(0.009)	(0.009)	(0.014)	(0.009)	(0.009)	(0.009)	(0.009)
Log. Price	-0.071***	-0.071***	-0.071***	-0.094***	-0.071***	-0.071***	-0.072***	-0.071***
	(0.001)	(0.001)	(0.001)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	-3.878***	-3.872***	-3.880***	-3.785***	-3.878***	-3.867***	-3.914***	-3.870***
	(0.122)	(0.122)	(0.123)	(0.322)	(0.123)	(0.123)	(0.122)	(0.122)
Category	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	177193	177193	177193	86834	177193	177193	177193	177193
Mean of dep. Var.	0.10	0.10	0.10	0.51	0.10	0.10	0.10	0.10
SD of dep. Var.	1.55	1.55	1.55	1.71	1.55	1.55	1.55	1.55
Adjusted R^2	0.294	0.294	0.294	0.288	0.294	0.294	0.295	0.294

NOTES: The table shows descriptive regressions analyzing the relationship between the presence of privacy sensitive permissions and app demand. The dependent variable is demand for the app measured by log. number of monthly new ratings of an app. The coefficient of interest analyzes the relationship between an app's demand and our privacy measures. Each column presents the results obtained when using an alternative privacy measure. Column 1 introduces an indicator for each number of permission (having 1, 2, and 3 or more permissions). Column 2 uses a dummy variable which is equal to one if an app uses at least one privacy-sensitive permission which was classified as very problematic by 450 microworkers we surveyed on Amazon's mechanical turk. In Column 3 we look at privacy sensitive permissions that are unusual for the app's category. Within a category we flag a privacy-sensitive permission as problematic only if paid apps of this category use this permission on average less often than the overall average paid app. Column 4 uses the 'privacygrade' by Lin, Hong, and Sadeh. (2014), that was made available on *privacygrade.org* in 2014. The dummy is equal to one if the the app got a rating equal to 'B', 'C' or 'D', i.e. a rating indicating the app being privacy-intrusive. In Columns 5 & 6 we introduce a crossterm that is equal to one if an app uses both at least one privacy-sensitive permission and has internet access. Column 7 disaggregates the privacy sensitive permissions into functionality-related types of permissions. Column 8 uses an alternative definition of privacy-sensitive permissions from previous research by Sarma, Li, Gates, Potharaju, Nita-Rotaru, and Molloy (2012), which defines only 12 permissions as privacy-sensitive. Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table A10: Alternative Estimation Specifications

	Tobit		Heckman		Netw.Eff.	IV-Privacy		IV-Price	
Log. $\Delta Ratings$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$D_{Privacy}$	-0.094***	-0.095***	-0.063***	-0.164***	-0.069***	-0.918***	-0.372***	-0.091***	-0.063***
	(0.017)	(0.017)	(0.009)	(0.024)	(0.007)	(0.049)	(0.017)	(0.009)	(0.017)
$\#_{CleanPerm}$	0.055***	0.057***	0.038***	0.019***	0.026***	0.065***	0.044***	0.043***	0.082***
	(0.004)	(0.004)	(0.002)	(0.005)	(0.002)	(0.004)	(0.003)	(0.003)	(0.007)
Log. Installations					0.417***				
					(0.002)				
$D_{Internet}$	-0.325***	-0.333***	-0.184***	-0.423***	-0.168***	-0.099***	-0.177***	-0.289***	-0.005
	(0.020)	(0.021)	(0.010)	(0.030)	(0.007)	(0.012)	(0.011)	(0.014)	(0.017)
D_{Ads}	0.436***	0.443***	0.234***	0.291***	0.203***	0.243***	0.253***	0.198***	0.043**
	(0.018)	(0.018)	(0.010)	(0.023)	(0.007)	(0.011)	(0.011)	(0.011)	(0.020)
Log. Price	-0.172***	-0.174***	-0.068***	-0.157***	0.040***	-0.074***	-0.074***	-0.108***	-0.687***
	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.004)	(0.094)
Constant	-8.802***	-8.975***	-3.533***	-5.781***	-6.472***	-4.141***	-4.305***	-3.970***	-3.300***
	(0.266)	(0.271)	(0.127)	(0.319)	(0.100)	(0.136)	(0.141)	(0.128)	(0.197)
Category	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	177193	177193	185533	177193	177193	136040	137146	177193	48272
Mean of dep. Var.	0.10	0.10	0.10	2.40	0.10	0.10	0.10	0.10	-0.50
SD of dep. Var.	1.55	1.55	1.55	2.52	1.55	1.55	1.56	1.55	1.06
Adjusted R^2					0.534	0.256	0.324	0.269	0.047

Notes: The table analyzes the robustness of our main demand-side results to using alternative estimation strategies. The dependent variable is app demand measured by the log. number of monthly new ratings, and the main variable of interest is a dummy that indicates the presence of privacy-sensitive permissions. All columns show cross section results. Columns 1 & 2 show Tobit-regressions that account for the fact that the dependent variable might be censored, especially might be left-censored at demand equal to 0. Column 1 sets the left-censoring limit to 0 new ratings, whereas in Column 2 in addition a right-censoring limit equal to 5 is set. Columns 3 & 4 contain results from Heckman selection models, where the regression equation is identical to our baseline cross-section demand specification, i.e. the dependent variable is the log. number of monthly or biannual new ratings, and the selection equation models app survival. In column 3 survival is modeled by comparing apps which are observed throughout the period April to September 2012 to those which are observed in April 2012 but which cannot be observed in later months. In column 4 survival is modeled by comparing apps within our baseline cross-section from April 2012 which survive until 2014 to those which are observed in April 2012 but are not observed in 2014. In both selection models we apply Heckman's two-step consistent estimator and use the information on code size as the selection variable, i.e. we include the code size only in the selection equation but not in the regression equation. In Column 5 we control for the existing user-base by including a control for the stock of existing installations (log. number of installations). In Columns 6 and 7 we estimate a 2SLS model and instrument the variable of interest to account for the endogeneity of the developers' privacy model choice. In Column 6 we instrument the privacy-dummy by the share of competing apps which use privacy-sensitve permissions ($ShareComp_{Privacy}$). In Column 7 we instrument the privacy-dummy by the share of the apps of the developer which use privacy-sensitive permissions ($ShareDev_{Privacy}$). In Columns 8 and 9 we instrument the app price by using in both specifications two potential cost shifters: the log. code size and the log. number of apps a developer offers in the Google Play Store. In Column 8 we use the full cross-section, whereas in Column 9 we use only the sample of paid apps. Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table A11: Excluding the Most and Least Successful Apps

	W/o Top-Apps		W/o Flop-Apps		W/o Top- and Flop-Apps	
Log. $\Delta Ratings$	(1)	(2)	(3)	(4)	(5)	(6)
$D_{Privacy}$	-0.064***	-0.079***	-0.011	-0.086***	-0.030***	-0.050***
	(0.008)	(0.007)	(0.012)	(0.011)	(0.010)	(0.010)
$D_{NumInst}$		1.545***		1.303***		0.946***
		(0.011)		(0.012)		(0.011)
$D_{Privacy} \times D_{NumInst}$		0.036**		0.126***		0.009
		(0.015)		(0.017)		(0.014)
$\#_{CleanPerm}$	0.019***	0.019***	0.036***	0.032***	0.017***	0.018***
	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)
$D_{Internet}$	-0.114***	-0.093***	-0.197***	-0.172***	-0.092***	-0.090***
	(0.008)	(0.007)	(0.014)	(0.012)	(0.011)	(0.010)
D_{Ads}	0.170***	0.154***	0.182***	0.188***	0.102***	0.116***
	(0.008)	(0.007)	(0.012)	(0.011)	(0.010)	(0.009)
Log. Price	-0.055***	-0.026***	-0.071***	-0.023***	-0.046***	-0.016***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	-2.777***	-2.924***	-3.228***	-3.462***	-1.535***	-1.906***
	(0.103)	(0.090)	(0.192)	(0.167)	(0.151)	(0.135)
Category	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	168767	168767	79847	79847	71421	71421
Mean of dep. Var.	-0.12	-0.12	1.44	1.44	1.09	1.09
SD of dep. Var.	1.23	1.23	1.44	1.44	1.04	1.04
Adjusted R^2	0.231	0.416	0.240	0.409	0.149	0.303

NOTES: The table shows the relationship between the presence of privacy-sensitive permissions and app demand for subsamples of our data where we exclude the tails of the distribution with respect to our dependent variable, i.e. the most and the least successful apps. App demand is measured by the log. number of monthly new ratings of an app. In Columns 1 and 2 we exclude the most succesful apps, i.e. the upper 5 percentiles with respect to the number of new ratings in April 2012. In Columns 3 and 4 we exclude the least successful apps, i.e. those without any new ratings in April 2012. In Columns 5 and 6 we exclude both groups, i.e. the upper 5 percent of most successful apps and those having no new rating in April 2012. In Columns 2, 4 and 6 we add a dummy which is equal to one if the app in the past had accumulated a stock of at least 10000 or more installations and also add an interaction of this dummy with the privacy-dummy. All specifications control for the number of unproblematic permissions ($\#CleanPerm.$). Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

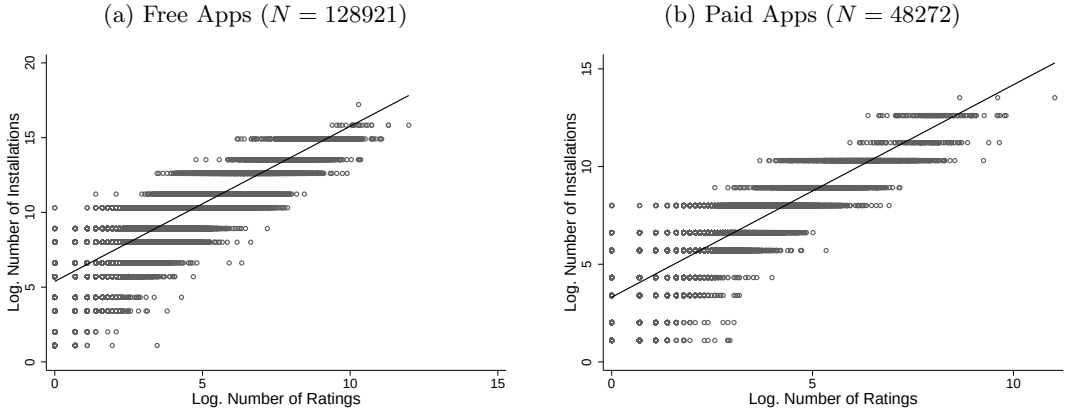
1.2 Demand Measures

In this section we illustrate the relationship between apps' installations and ratings as well as the relationship between apps' number of ratings and apps' success measured by app ranks.

Relationship between Installations and Ratings: Our main measure of app demand is the log. number of new ratings an app has received within a month. We use it as a demand proxy since the optimal measure of app demand, the number of new installations, is a very noisy measure due to the fact that the total number of installations is published in a discrete form (17 steps). More explicitly, changes in the number of installations for most of the apps are observed only very rarely, i.e. in most cases the monthly number of new installations is equal to zero, and in cases where we observe a change in the number of installations this observed change most likely overstates the true change in the monthly number of installations. However, since we have exact and continuous information about the number of ratings of an app, we can use this as an alternative demand measure. We can do so, since, as we show in the following, (changes in) the number of installations and (changes in) the number of ratings are on average extremely closely related to each other.

To illustrate the relationship between both measures visually, Figure A3 shows for the April 2012 cross-section of free and paid apps the relationship between the log. number of installations and the log. number of ratings. As can be seen, for both types of apps a strong positive relationship between both measures exists.

Figure A3: Relationship between Level of Installations and Ratings for Free and Paid Apps



Notes: Both figures display the relationship between apps' log. number of installations and their log. number of ratings. The left plot shows the relationship for free apps, whereas the right one contains that of paid apps. In both cases a linear trend is added. The data used is equal to the cross-section data set from April 2012 used in the estimation sections.

In addition, Table A12 shows more descriptive, econometric, evidence on the relationship between installations and ratings. The first column shows evidence on the relationship between log. installations and log. ratings, where we find an estimation coefficient slightly above one and a R^2 of around 0.7. This indicates that an increase in the number of ratings by one percent comes with an increase in the number of installations by around one percent. Columns 2 and 3 use the cross-section from April 2012 and analyze the relationship based on changes in both variables within one month. Column 2 uses all available observations, whereas Column 3 drops observations with no change in

the number of installations in April. As can be seen, even in these cases where our measure of monthly changes in the number of installations is extremely noisy (due to the short time period of one month), we can observe for both versions a strong and positive relationship between installations and ratings. In Column 4 and 5 we also use the cross-section from April 2012 but analyze changes between April and September. Column 4 uses all observations, whereas Column 5 drops those which exhibit no change in installations between April and September. Doing so, the previous finding of a strong and positive relationship is even more pronounced, which is not too surprising since measurement error looses relative weight compared to the version based on monthly changes. Columns 6 and 7 use the sample of observations for which we have information both in 2012 and in 2014 and analyzes changes in installations and ratings within those two years. Column 6 uses all observations, whereas Column 7 uses only those with changes in the number of installations between 2012 and 2014. Going one step further and exploiting changes within two years of observation, we again find, as for the specification in levels, coefficients of around one and R^2 values of 0.4 and 0.8. To estimate the relationship in Column 8, which is based on aggregated data, we apply a two-step approach: (1) First, we aggregate single data points into average ones. For doing so, we split the sample, which is ordered by the number of new ratings, into 100 quartiles and then compute for each quartile the average number of new ratings and new installations.[1] (2) Second, based on the log-values of the average data points we estimate a simple linear log-log model of the relationship between new installations and new ratings, for which the results are given in Column 8. As can be seen, an extremely close relationship between the log. number of new installations and the log. number of new ratings exists, with an R^2 close to one. Visually, this relationship is illustrated by Figure 1.

Relationship between Ratings and App Ranks: In a second step we aim at illustrating the close relationship between our demand measure and a demand measure based on app ranks. The Google Play store, as well as Apple's iOS store, provide app ranks for the most successful apps by category. In table A13 we show the correlation between (a) app ranks which we compute based on changes in apps' number of ratings and (b) their official app ranks in the Google Play Store (taken from App Annie). The correlation is given for apps for which we have an overall rank (Columns 1 to 3) and for apps for which we have a rank within the games category (Columns 4 to 6). Column 1 and 4 contain all apps, whereas Columns 2 and 5 use only apps which are for free, wherease Columns 3 and 6 analyze paid apps. The dependent variable is the official app rank, whereas the independent variable is its rank based on the change in the number of ratings which we observe. In all regression we do not include a constant.

1.3 Context-Dependent Privacy-Sensitive Permissions

In this robustness check, we test whether the main demand-side results are robust to using a context-specific definition of privacy-sensitive permissions. We consider this relevant, since such a definition allows to consider category-specific functionalities. For example, 'running'-apps can provide better service if they are able to geo-locate their users, while other apps (e.g., a mail client) do not need this ability. Thus, the use of certain permissions might allow an app to access private information

[1] Due to the skewed distribution of the data, STATA only generates 34 quartiles.

Table A12: Relationship between Installations and Ratings

	Level	Growth		Growth Apr-Sep		Growth 12-14		Means
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log. Ratings	1.178***							
	(0.002)							
Log. Δ Ratings		0.461***	0.938***					0.955***
		(0.006)	(0.010)					(0.024)
Log. Δ_{AprSep} Ratings				0.815***	0.952***			
				(0.005)	(0.004)			
Log. Δ_{1214} Ratings						1.132***	0.929***	
						(0.005)	(0.002)	
Constant	4.518***	-0.463***	6.752***	0.073***	6.158***	1.966***	5.815***	5.959***
	(0.006)	(0.005)	(0.026)	(0.006)	(0.014)	(0.014)	(0.009)	(0.076)
Observations	177193	177193	10988	176212	34620	125213	74040	34
Adjusted R^2	0.720	0.094	0.427	0.181	0.609	0.318	0.788	0.980

Notes: The table shows descriptive econometric evidence on the relationship between installations and ratings. The first Column shows the relationship in levels, i.e. the relationship between the log. number of installations and log. the number ratings. Columns 2 to 8 contain estimates of the relationship in changes, i.e. the relationship between the log. number of new installations and the log. number of new ratings. Columns 2 and 3 use the cross-section from April 2012 and analyze the relationship based on changes in both variables within one month. Column 2 uses all available observations, whereas Column 3 drops observations with no change in the number of installations in April. In Column 4 and 5 we also use the cross-section from April 2012 but analyze changes between April and September. Column 4 uses all observations, whereas Column 5 drops those which exhibit no change in installations between April and September. Columns 6 and 7 use the sample of observations for which we have information both in 2012 and in 2014 and analyzes changes in installations and ratings within those two years. Column 6 uses all observations, whereas Column 7 uses only those with changes in the number of installations between 2012 and 2014. For the estimation in Column 8 we aggregate single data points into average ones by splitting the sample, which is ordered by the number of new ratings, into 100 quartiles and then compute for each quartile the average number of new ratings and new installations and then, based on the log-values of the average data points, we estimate a simple linear log-log model of the relationship between new installations and new ratings. Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table A13: Relationship between Ranks based on Ratings and Ranks from App-Annie

	All Apps			Games		
	Free&Paid	Free	Paid	Free&Paid	Free	Paid
$RANK_{AllApps}$	0.880***	0.855***	0.893***			
	(0.023)	(0.036)	(0.029)			
$RANK_{GAMES}$				0.889***	0.851***	0.909***
				(0.020)	(0.033)	(0.026)
Observations	407	180	227	465	207	258
Adjusted R^2	0.774	0.729	0.796	0.787	0.729	0.818

Notes: The table shows correlations between (a) app ranks which we compute based on changes in apps' number of ratings and (b) their official app ranks in the Google Play Store (taken from App Annie). The correlation is given for apps for which we have an overall rank (Columns 1 to 3) and for apps for which we have a rank within the games category (Columns 4 to 6). Column 1 and 4 contain all apps, whereas Columns 2 and 5 use only apps which are for free, wherease Columns 3 and 6 analyze paid apps. The dependent variable is the official app rank, whereas the independent variable is its rank based on the change in the number of ratings which we observe. In all regression we do not include a constant. Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

might be related to its functionality and might not only exist for collecting information about users. In Table A14 we consider category-specific definitions of privacy-sensitive permissions, and tolerate such permissions that are common and necessary for a certain category of apps.

Data and Variables: To identify category-specific permission requirements, we exploit the Play Store's category tree and analyze which permissions are common in each category and thus might be required for the functionality of typical apps within this category. Based on this information we generate an alternative measure of category-specific privacy-sensitive permissions, which takes the categories usual functionality and permission-needs into account. We generate a dummy variable $D_{PrivcCatSpec}$ which is equal to one if an app uses at least one privacy-sensitive permission which is relatively unusual within the app's category. Based on the cross-section data set from April 2012, we define permissions as relatively uncommon within an app category if paid apps of this category use this permission on average less often than the overall paid app.[2] Thus, a privacy-sensitive permission is classified as problematic within a category if it is relatively uncommon in this category, i.e. if a higher share of apps in other categories use this permission (for an overview about which permissions are classified as category-specific privacy-sensitive in which category, see Table A15).

Results: Table A14 shows the results which we obtained using the category-specific measure of privacy-sensitive permissions. The dependent variable is as in the baseline specifications the monthly number of new reviews, and $D_{PrivcCatSpec}$ indicates the presence of privacy-sensitive permissions that are unusual for a given app category. We show four specifications using the cross-section (cols. 1-4) and three different panel specifications (cols. 5-7). The results show that the negative demand effect of category-specific privacy-sensitive permissions is statistically significant for the cross-section (cols. 1-4) and in two out of the three panel specifications (cols. 5-7). Only in specification 6, where we control for time-varying factors but do not ensure that apps do not change their description over time and thus might have changed their functionality, we find a negative but insignificant effect.

In Columns 1 and 2 we use the full sample and vary the number of controls. Column three shows the results only for free apps and column 4 shows the results exclusively for paid apps. The coefficient is largest for paid apps, suggesting that paying users avoid apps who request sensitive *and unusual* permissions (which cannot be related to a functionality). Among the panel results, Columns 5 & 6 use the large panel, while Column 7 focuses on apps that did not update their description of functionality (but changed their permissions). We see the strongest negative effect when apps update their permission use without changing functionality in a visible way.

[2]We use paid apps for this definition, since we expect them to use to a higher degree only such permissions which are necessary for their functionality, whereas free apps, according to our findings, do also use permissions which are not necessary for the apps' functionality but which are related to monetisation.

Table A14: Using a Category-Specific Privacy Measure

	Cross-Section				Panel		
Log. $\Delta Ratings$	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$D_{PrivCatSpec}$	-0.064***	-0.072***	-0.025**	-0.156***	-0.039*	-0.015	-0.062**
	(0.012)	(0.011)	(0.012)	(0.020)	(0.020)	(0.022)	(0.028)
$\#_{CleanPerm}$	0.115***	0.037***	0.037***	0.053***	-0.010**	-0.011**	-0.002
	(0.003)	(0.003)	(0.003)	(0.006)	(0.004)	(0.005)	(0.006)
$D_{Internet}$		-0.204***	-0.258***	-0.080***	-0.021	-0.015	0.014
		(0.009)	(0.012)	(0.013)	(0.054)	(0.053)	(0.071)
D_{Ads}		0.233***	0.240***	0.037**	-0.008	-0.011	-0.048
		(0.009)	(0.010)	(0.017)	(0.032)	(0.033)	(0.043)
Log. Price		-0.071***	0.000	0.100***	-0.043***	-0.043***	-0.037***
		(0.001)	(.)	(0.007)	(0.011)	(0.011)	(0.013)
D_{Other}		0.047***	0.014	0.012		0.017	
		(0.009)	(0.011)	(0.014)		(0.022)	
Log. Length Desc.		0.261***	0.279***	0.133***		0.000	
		(0.004)	(0.005)	(0.006)		(0.023)	
Log. Size (in KB)		0.062***	0.079***	0.010***		0.041**	
		(0.002)	(0.003)	(0.003)		(0.017)	
Number Screenshots		0.085***	0.106***	0.057***		0.029**	
		(0.002)	(0.003)	(0.003)		(0.011)	
Dummy: Video		0.204***	0.271***	0.224***		-0.139**	
		(0.012)	(0.016)	(0.018)		(0.058)	
Log. Average Rating		0.200***	0.372***	0.083***		0.272***	
		(0.007)	(0.010)	(0.007)		(0.098)	
Dummy: Top-Dev.		1.130***	1.150***	1.142***		-0.178***	
		(0.058)	(0.088)	(0.082)		(0.014)	
App Version		0.028***	0.038***	0.035***		0.030*	
		(0.004)	(0.005)	(0.006)		(0.015)	
Log. AppsByDev		-0.113***	-0.168***	-0.046***		-0.161***	
		(0.002)	(0.003)	(0.002)		(0.029)	
Log. InstByDev		0.183***	0.236***	0.100***		-0.011	
		(0.002)	(0.002)	(0.002)		(0.014)	
Log. InstByComp		-0.007***	-0.010***	-0.008***		0.004	
		(0.002)	(0.002)	(0.002)		(0.004)	
Log. PriceOfComp		0.011***	0.012***	0.003***		-0.001	
		(0.001)	(0.001)	(0.001)		(0.001)	
Log. RatByComp		-0.698***	-0.819***	0.159**		-0.028	
		(0.061)	(0.078)	(0.078)		(0.129)	
Min. Android Vers.		-0.015	-0.029**	0.122***		0.059	
		(0.010)	(0.013)	(0.015)		(0.044)	
Max. Android Vers.		0.170***	0.171***	0.144***		-0.145	
		(0.020)	(0.024)	(0.029)		(0.096)	
Constant	-0.283***	-3.879***	-3.557***	-3.432***	1.162***	1.251**	0.740***
	(0.008)	(0.123)	(0.152)	(0.172)	(0.128)	(0.561)	(0.154)
Category	No	Yes	Yes	Yes	No	Yes	No
Month	No	No	No	No	Yes	Yes	Yes
Observations	177193	177193	128921	48272	33095	33095	15220
Num. of Groups					6619	6619	3044
Mean of dep. Var.	0.10	0.10	0.33	-0.50	1.63	1.63	1.17
SD of dep. Var.	1.55	1.55	1.65	1.06	2.23	2.23	2.10
Adjusted R^2	0.048	0.294	0.285	0.262	0.026	0.033	0.020

NOTES: The table shows descriptive regressions analyzing the relationship between the presence of category-specific privacy-sensitive permissions and app demand. We look at privacy-sensitive permissions that are unusual for the app's category. Within a category we flag a privacy-sensitive permission as problematic only if paid apps of this category use this permission on average less often than the overall average paid app. In Columns 1 to 4 we provide cross-sectional results, whereas Columns 5 to 7 contain panel results. Column 3 restricts the sample to free apps, whereas Column 4 uses paid apps. Columns 5 shows the raw fixed effects regressions without controls, whereas in Column 6 we add control variables and dummies to control for the apps' categories and in Column 7 we restrict the analysis to apps that introduced new permissions without changing the app's description (no change in the length of description). Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table A15: Overview of Category-Specific Privacy-Sensitive Permissions

	INTERCEPT_OUTGOING_CALLS	GOOGLE_AUTH	READ_HISTORY_BOOKMARKS	READ_SMS	ACCESS_FINE_LOCATION	GET_ACCOUNTS	READ_CONTACTS	READ_SYNC_STATS	READ_PHONE_STATE	USE_CREDENTIALS	READ_LOGS	SUBSCRIBED_FEEDS_READ	RECORD_AUDIO	CAMERA	ACCESS_COARSE_LOCATION	RECEIVE_SMS	RECEIVE_MMS	RECEIVE_WAP_PUSH	ACCESS_DOWNLOAD_MANAGER	ACCESS_LOCATION_EXTRA_COMMANDS	MANAGE_ACCOUNTS	NFC	READ_INPUT_STATE	MOUNT_UNMOUNT_FILESYSTEMS	ACCOUNT_MANAGER
Arcade & Action	●	○	●	●	●	○	●	●	○	●	●	●	●	●	●	●	●	●	●	●	○	○	●	●
Books & Reference	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Brain & Puzzle	●	○	●	●	●	○	●	●	○	●	●	●	●	●	●	●	●	●	●	●	●	○	●	●
Business	○	○	○	○	○	○	○	○	○	○	○	●	○	○	○	○	●	○	●	○	○	○	●	○
Cards & Casino	●	○	●	●	●	●	●	●	○	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Casual	●	●	●	●	●	○	●	●	○	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Comics	●	●	●	●	●	○	●	●	●	○	●	●	●	●	●	●	●	●	○	●	●	●	○	●
Communication	○	○	○	○	○	○	○	○	○	○	○	○	○	●	○	○	○	○	○	○	○	○	●	○
Education	●	●	○	●	●	●	●	●	●	●	●	○	○	●	●	●	●	●	○	●	●	●	●	●
Entertainment	●	●	●	○	●	○	●	●	○	●	●	●	○	○	●	●	●	●	●	●	●	●	●	●
Finance	●	●	●	●	●	○	●	●	●	○	●	●	●	○	●	●	●	●	●	●	○	●	●	○
Health & Fitness	●	●	●	●	○	●	●	●	○	●	●	●	●	○	○	●	●	●	●	○	●	●	●	●
Libraries & Demo	○	●	○	●	●	●	●	○	●	○	●	○	●	○	○	●	○	○	●	○	○	●	○	○
Lifestyle	●	●	●	●	○	●	●	○	●	●	●	●	●	○	○	●	●	●	●	○	●	●	○	●
Media & Video	○	○	○	●	●	○	●	●	○	○	○	●	○	○	○	●	●	●	●	●	○	●	●	●
Medical	●	●	●	●	●	○	●	●	○	●	●	●	●	●	●	●	●	●	●	●	○	●	●	●
Music & Audio	○	○	●	●	●	●	●	●	○	○	○	●	○	●	●	●	○	○	○	○	●	●	●	○
News & Magazines	●	○	○	●	○	○	●	●	○	○	○	●	●	○	○	○	●	●	●	○	○	○	●	●
Personalization	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	○	●	●	●	●	●	●
Photography	●	●	●	●	○	●	●	●	○	○	●	○	○	○	○	●	●	●	●	○	○	○	●	●
Productivity	○	○	○	○	○	○	○	○	●	○	○	○	○	○	○	○	○	○	○	○	○	○	●	○
Racing	●	○	●	●	●	○	●	●	○	○	●	●	●	●	●	●	●	●	●	●	○	●	●	●
Shopping	●	●	○	●	○	●	○	●	●	●	○	●	●	○	○	○	○	○	●	○	●	●	●	○
Social	○	○	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	○	○	○	●	●
Sports	●	●	●	●	○	○	○	●	○	○	●	●	○	○	○	●	●	●	●	○	●	●	●	○
Sports Games	●	●	●	●	●	○	●	●	○	●	●	●	●	●	●	●	●	●	●	●	○	●	●	●
Tools	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Transportation	○	●	○	○	○	●	○	●	○	●	●	●	○	○	○	○	●	●	○	○	●	○	●	●
Travel & Local	●	●	●	●	○	●	○	●	○	●	○	●	○	○	○	○	●	●	●	○	●	●	●	●
Weather	●	●	●	●	○	○	●	●	●	●	○	●	●	●	○	●	●	●	●	○	●	●	●	●

Notes: A '●' indicates that a permission is relatively uncommon in a category and is thus classified as category-specific privacy-sensitive. A '○' indicates that a permission is relatively common in a category and is thus classified as unproblematic. A permission is defined to be relatively common within an app category if paid apps of this category use this permission on average more often than the overall paid app.

2 Online Appendix B - Additional Evidence Detailed Regressions

2.1 Additional Descriptive Statistics

Table B1: Summary Statistics of the Pairs Datasets

	Pairs I		Pairs II		Pairs III	
	Free	Paid	Free	Paid	Free	Paid
Δ Ratings	73.81	8.80	67.33	6.08	81.16	2.65
Δ Installations	23895.46	456.34	8213.48	92.71	3833.90	101.76
Ratings	980.13	119.90	623.53	81.05	1420.45	62.58
Installations	2.1e+05	4428.21	1.3e+05	2739.82	4.1e+05	4167.34
$\#_{TotalPerm}$	3.63	2.99	3.78	3.10	4.39	2.18
$D_{Privacy}$	0.46	0.37	0.49	0.40	0.57	0.29
$\#_{Privacy}$	0.88	0.66	0.93	0.70	1.12	0.47
$\#_{CleanPerm}$	2.75	2.33	2.85	2.40	3.27	1.71
$D_{PrivCatSpec}$	0.15	0.10	0.14	0.08	0.23	0.05
$D_{MTurkEP2}$	0.11	0.11	0.12	0.12	0.11	0.09
D_{Google}	0.24	0.19	0.25	0.21	0.27	0.14
$D_{Sarmaetal}$	0.42	0.32	0.46	0.35	0.53	0.24
D_{ID}	0.27	0.19	0.30	0.22	0.40	0.15
$D_{Location}$	0.19	0.11	0.21	0.12	0.27	0.05
$D_{Communication}$	0.07	0.07	0.06	0.06	0.05	0.05
$D_{Profile}$	0.18	0.16	0.19	0.18	0.19	0.13
$D_{Internet}$	0.76	0.52	0.82	0.56	0.99	0.30
D_{Ads}	0.53	0.28	0.56	0.31	0.84	0.11
Price	0.00	1.46	0.00	1.37	0.00	1.19
Average Rating	3.85	4.20	3.79	4.14	3.93	4.21
Size (in KB)	3043.97	3734.91	3206.59	3039.23	2102.13	1848.41
Length Description	1052.04	1027.52	876.84	873.62	982.41	853.95
Number Screenshots	3.92	4.15	3.73	3.87	4.01	3.99
Dummy: Video	0.19	0.19	0.17	0.17	0.14	0.13
Dummy: Top-Dev.	0.01	0.01	0.01	0.01	0.02	0.02
Apps by Developer	33.55	33.55	14.47	14.47	10.60	10.60
Average Installations of Developer	58752.29	1.3e+05	57842.83	91748.60	65842.46	2.1e+05
Observations	14422		3998		708	

Notes: The table provides an overview over the most important variables, and shows the corresponding descriptive statistics for the three pairs datasets in this paper. For each dataset we show two columns, where the left column shows averages for free apps and the second column for paid apps.

2.2 Additional Robustness Checks

Note: This section is not intended for publication in the journal, instead we will make it available online. This section presents additional results from robustness checks that had to be excluded from the paper for reasons of space as well as more extensive descriptions of data sets and estimation results presented in the paper.

2.2.1 Privacy and Demand: The Role of Apps' Previous Success

We further analyze how the relationship between privacy-sensitive permissions and app demand varies with an app's past success. This robustness check shows that our main results are not driven by either very successful or unsuccessful apps only. In Table B2, we divide the estimation sample into four groups according to apps previous success.

Data Preparation and Additional Variables: To analyze how the relationship of interest varies with previous app success, we split our cross-section sample into 20 quantiles according to the total number of ratings an app has received so far. For example, those apps which are in the first two quantiles have the greatest past success, and the highest stock of ratings. We then separately estimated the relationship of interest for the apps in quantiles 1-2 (Column 1), quantiles 3-4 (Column 2), quantliles 5-10 (Column 3) and the remaining apps (quantiles 11 to 20) Column 4.

Results: As before, app demand in Table B2 is measured by the log. number of monthly new ratings of an app. The coefficient of interest analyzes the relationship between an app's downloads and our measures of privacy-sensitive permissions. The dependent variable is app demand and the variable of interest is an indicator for presence of privacy-sensitive permissions ($D_{Privacy}$). Column 1 analyzes the top 10% most successful apps. Column 2 analyzes the top 10-20% most successful apps. Column 3 focuses on the top 20-50% most successful apps, and column 4 analyzes the remaining 50% of least successful apps. All specifications control for the number of unproblematic permissions ($CleanPerm.$), and for an app's other observed characteristics on the Play Store (the app's price, description, ratings, categorical dummies, etc.). We also control for internet access, and ad-specific permissions.

While the coefficient of interest is insignificant for the top 10% of the apps, it is largest in columns 2 and 3, i.e. for intermediate apps, and somewhat weaker for unsuccessful apps. These findings highlight, that our main results are driven by the large mass of "average" apps, and that they actually apply to top apps to a far lesser extent. Moreover, the findings in this robustness check confirm the insights from the analysis in Table B5, and especially the finding, that successful apps almost do not have to worry about using privacy-intrusive permissions. However, apps that are not in the top-segment are faced with a negative relationship of permissions and demand, suggesting that they are at a competitive disadvantage compared to bestselling apps.

2.2.2 User Assessment and Survival

In Table B3 we explore whether apps with fewer intrusive permissions induce higher user satisfaction and are more likely to survive. Given our results for demand effects of privacy-sensitive permissions,

Table B2: Samples based on Past App Success

	1st-10th pct	11th-20th pct	21st-50th pct	51st-100th pct
Log. $\Delta Ratings$	(1)	(2)	(3)	(4)
$D_{Privacy}$	-0.016	-0.133***	-0.090***	-0.026***
	(0.026)	(0.024)	(0.013)	(0.006)
$\#_{CleanPerm}$	0.011***	0.013**	0.013***	0.004***
	(0.004)	(0.006)	(0.003)	(0.001)
$D_{Internet}$	-0.204***	-0.121***	-0.092***	-0.021***
	(0.034)	(0.029)	(0.014)	(0.005)
D_{Ads}	0.420***	0.394***	0.264***	0.088***
	(0.029)	(0.026)	(0.013)	(0.006)
Log. Price	-0.085***	-0.065***	-0.049***	-0.014***
	(0.003)	(0.003)	(0.001)	(0.000)
D_{Other}	0.083***	0.083***	0.065***	0.023***
	(0.025)	(0.025)	(0.013)	(0.006)
Log. Length Desc.	0.321***	0.201***	0.137***	0.064***
	(0.014)	(0.013)	(0.006)	(0.002)
Log. Size (in KB)	0.120***	0.100***	0.056***	0.013***
	(0.008)	(0.007)	(0.003)	(0.001)
Number Screenshots	0.082***	0.084***	0.059***	0.022***
	(0.006)	(0.006)	(0.003)	(0.001)
Dummy: Video	0.032	-0.074**	0.019	0.014*
	(0.028)	(0.032)	(0.018)	(0.008)
Log. Average Rating	2.183***	1.226***	0.557***	0.019***
	(0.089)	(0.061)	(0.022)	(0.004)
Dummy: Top-Dev.	0.387***	-0.029	-0.086	-0.008
	(0.062)	(0.128)	(0.092)	(0.045)
App Version	-0.051***	-0.080***	-0.023***	-0.009***
	(0.013)	(0.012)	(0.006)	(0.002)
Log. AppsByDev	-0.025***	-0.003	-0.024***	-0.031***
	(0.010)	(0.008)	(0.004)	(0.001)
Log. InstByDev	0.115***	0.048***	0.058***	0.025***
	(0.005)	(0.005)	(0.003)	(0.001)
Log. InstByComp	0.041***	0.012**	-0.006**	-0.008***
	(0.007)	(0.006)	(0.003)	(0.001)
Log. PriceOfComp	0.024***	0.001	-0.003***	-0.004***
	(0.003)	(0.002)	(0.001)	(0.000)
Log. RatByComp	-0.671***	-0.422**	-0.247***	-0.223***
	(0.187)	(0.167)	(0.091)	(0.040)
Min. Android Vers.	0.681***	0.786***	0.413***	0.074***
	(0.036)	(0.033)	(0.017)	(0.006)
Max. Android Vers.	0.274***	0.322***	0.234***	0.060***
	(0.082)	(0.064)	(0.026)	(0.010)
Constant	-7.316***	-5.818***	-4.139***	-1.517***
	(0.447)	(0.369)	(0.173)	(0.073)
Category	Yes	Yes	Yes	Yes
Observations	17711	17396	51021	91065
Mean of dep. Var.	2.91	1.37	0.20	-0.74
SD of dep. Var.	1.67	1.47	1.21	0.60
Adjusted R^2	0.340	0.308	0.193	0.080

Notes: The table shows the relationship between the presence of privacy-sensitive permissions and app demand for subsamples of our data which are defined according to apps past success. App demand is measured by the log. number of monthly new ratings of an app. We split our cross-section sample into 20 quantiles according to the total number of ratings an app has received so far. In Column 1 we estimate our model for those apps which are in the first two quantiles, i.e. which have the highest stock of ratings. In Columns 2 apps from the 3rd and 4th quantile are used. In Column 3 apps from the 5th to the 10th quantile are analyzed. In Column 4 the remaining apps, i.e. those from the 11th to the 20th quantile are used. All specifications control for the number of unproblematic permissions ($CleanPerm.$). Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

we expect average apps that use privacy-sensitive permissions also to face lower user-satisfaction and, ultimately, lower survival rates.

Data Preparation and Additional Variables: Table B3 explores the relationship between apps' use of privacy-sensitive permissions and two alternative success measures: apps' average ratings (Columns 1-4) and their long-run survival rates (Columns 5-6). All results are based on the cross-section from April 2012. In Columns 1 and 2 the dependent variable is the log. average value of the ratings the app has received in April 2012. In Columns 3 and 4 the dependent variable is the log. average value of the ratings the app has received between April and September 2012. In Columns 5 and 6 we analyze app survival over two years. The dependent variable is a dummy which equals one, if an app from April 2012 was still available in 2014 (i.e. if we observe it in the data set we collected in 2014). All specifications control for the number of unproblematic permissions ($CleanPerm.$).

Results: The first four columns show that apps which do not use privacy-sensitive permissions or do use less privacy-sensitive permissions are rated better by users. Moreover, apps which use privacy-sensitive permissions are also less likely to survive until 2014, as can be seen in Columns 5 and 6. In short, the demand side results carry over to user satisfaction and survival.

2.2.3 Moderating Factors (Alternative Specifications)

Table B3: User Assessment and Survival

	User Assessment (Avg. Rating)				Survival ($D_{Survive r}$)	
	(1)	(2)	(3)	(4)	(5)	(6)
$D_{Privacy}$	-0.022***		-0.018***		-0.028***	
	(0.003)		(0.003)		(0.003)	
$\#_{Privacy}$		-0.011***		-0.009***		-0.017***
		(0.001)		(0.001)		(0.001)
$\#_{CleanPerm}$	0.000	0.003***	0.000	0.003***	-0.005***	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$D_{Internet}$	-0.054***	-0.058***	-0.056***	-0.060***	-0.041***	-0.046***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)
D_{Ads}	0.009**	0.006	0.014***	0.012***	-0.025***	-0.030***
	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
Log. Price	-0.002***	-0.003***	-0.005***	-0.005***	0.003***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
D_{Other}	0.006*	0.005	-0.003	-0.004	-0.005*	-0.006**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Log. Length Desc.	0.006***	0.006***	0.006***	0.006***	0.001	0.001
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Log. Size (in KB)	0.009***	0.009***	0.012***	0.012***	-0.007***	-0.007***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Number Screenshots	0.012***	0.012***	0.013***	0.013***	0.005***	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Dummy: Video	0.014***	0.014***	0.012***	0.012***	0.007**	0.008**
	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
Dummy: Top-Dev.	0.007	0.006	-0.013	-0.014	-0.041***	-0.042***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.015)	(0.015)
App Version	0.004**	0.004**	0.004***	0.004***	-0.006***	-0.006***
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Log. AppsByDev	-0.007***	-0.006***	-0.001	-0.000	-0.061***	-0.061***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Log. InstByDev	0.015***	0.015***	0.015***	0.015***	-0.001	-0.001**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
Log. InstByComp	-0.007***	-0.007***	-0.005***	-0.005***	-0.002***	-0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Log. PriceOfComp	-0.001***	-0.001***	-0.001***	-0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log. RatByComp	0.449***	0.446***	0.436***	0.434***	-0.051***	-0.051***
	(0.024)	(0.024)	(0.020)	(0.020)	(0.020)	(0.020)
Min. Android Vers.	-0.000	0.001	0.004	0.004	-0.044***	-0.044***
	(0.005)	(0.005)	(0.004)	(0.004)	(0.003)	(0.003)
Max. Android Vers.	0.020**	0.020**	0.006	0.006	0.011	0.011
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)	(0.007)
Log. Average Rating					0.017***	0.016***
					(0.003)	(0.003)
Constant	0.354***	0.353***	0.360***	0.361***	1.130***	1.126***
	(0.055)	(0.055)	(0.046)	(0.045)	(0.041)	(0.041)
Category	Yes	Yes	Yes	Yes	Yes	Yes
Observations	68248	68248	102594	102594	177193	177193
Mean of dep. Var.	1.29	1.29	1.29	1.29	0.73	0.73
SD of dep. Var.	0.35	0.35	0.35	0.35	0.45	0.45
Adjusted R^2	0.043	0.044	0.052	0.052	0.118	0.119

Notes: This table shows the relationship between apps' use of privacy-sensitive permissions and two alternative success measures: apps' average rating (Columns 1-4) and their long-run survival (Columns 5-6). All results are based on the cross-section from April 2012. In Columns 1 and 2 the dependent variable is the log. average of the ratings the app has received in April 2012. In Columns 3 and 4 the dependent variable is the log. average of the ratings the app has received between April and September 2012. In Columns 5 and 6 the dependent variable is a dummy which is equal to one, if an app from April 2012 was still available in our data set collected in 2014. All specifications control for the number of unproblematic permissions (*CleanPerm.*). Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table B4: Alternative Moderating Factors

	Top-Developer		Alexa Rank		Games		Pricing Model	
Log. $\Delta Ratings$	No	Yes	No	Yes	No	Yes	Free	Paid
$D_{Privacy}$	-0.065***	0.088	-0.055***	0.010	-0.082***	-0.020	-0.026**	-0.121***
	(0.009)	(0.151)	(0.010)	(0.172)	(0.010)	(0.022)	(0.011)	(0.014)
$\#_{CleanPerm}$	0.036***	0.097***	0.035***	0.051*	0.037***	0.098***	0.037***	0.054***
	(0.003)	(0.031)	(0.003)	(0.028)	(0.003)	(0.009)	(0.003)	(0.006)
$D_{Internet}$	-0.195***	0.023	-0.187***	0.152	-0.211***	-0.201***	-0.256***	-0.075***
	(0.009)	(0.231)	(0.010)	(0.264)	(0.010)	(0.024)	(0.012)	(0.013)
D_{Ads}	0.232***	0.360**	0.226***	-0.251	0.228***	0.157***	0.241***	0.039**
	(0.009)	(0.164)	(0.010)	(0.173)	(0.010)	(0.024)	(0.010)	(0.017)
Log. Price	-0.071***	-0.108***	-0.071***	-0.107***	-0.068***	-0.095***	0.000	0.099***
	(0.001)	(0.011)	(0.001)	(0.024)	(0.001)	(0.002)	(.)	(0.007)
D_{Other}	0.053***	-0.293**	0.070***	0.137	0.023**	0.144***	0.016	0.022
	(0.009)	(0.129)	(0.010)	(0.164)	(0.010)	(0.027)	(0.011)	(0.015)
Log. Length Desc.	0.262***	0.492***	0.277***	0.372***	0.255***	0.291***	0.280***	0.135***
	(0.004)	(0.084)	(0.004)	(0.087)	(0.004)	(0.011)	(0.005)	(0.006)
Log. Size (in KB)	0.063***	-0.008	0.062***	0.200***	0.050***	0.117***	0.080***	0.011***
	(0.002)	(0.065)	(0.002)	(0.054)	(0.002)	(0.006)	(0.003)	(0.003)
Number Screenshots	0.085***	0.050**	0.083***	0.221***	0.086***	0.085***	0.105***	0.057***
	(0.002)	(0.026)	(0.002)	(0.040)	(0.002)	(0.006)	(0.003)	(0.003)
Dummy: Video	0.199***	0.347***	0.191***	0.910***	0.204***	0.177***	0.271***	0.225***
	(0.012)	(0.134)	(0.013)	(0.224)	(0.015)	(0.024)	(0.016)	(0.018)
Log. Average Rating	0.198***	0.747***	0.204***	-0.216	0.167***	0.355***	0.371***	0.083***
	(0.007)	(0.228)	(0.008)	(0.300)	(0.008)	(0.020)	(0.010)	(0.007)
Dummy: Top-Dev.	0.000	0.000	0.949***	0.638**	1.026***	1.295***	1.151***	1.169***
	(.)	(.)	(0.065)	(0.292)	(0.074)	(0.092)	(0.088)	(0.082)
App Version	0.029***	-0.161*	0.032***	-0.027	0.029***	0.017*	0.039***	0.036***
	(0.004)	(0.083)	(0.004)	(0.153)	(0.004)	(0.009)	(0.005)	(0.006)
Log. AppsByDev	-0.113***	-0.387***	-0.110***	0.148	-0.105***	-0.180***	-0.169***	-0.047***
	(0.002)	(0.072)	(0.002)	(0.126)	(0.002)	(0.005)	(0.003)	(0.002)
Log. InstByDev	0.183***	0.192***	0.188***	0.154***	0.179***	0.203***	0.236***	0.100***
	(0.002)	(0.040)	(0.002)	(0.032)	(0.002)	(0.004)	(0.002)	(0.002)
Log. InstByComp	-0.008***	0.041	-0.008***	-0.037	-0.007***	0.003	-0.010***	-0.007***
	(0.002)	(0.035)	(0.002)	(0.047)	(0.002)	(0.006)	(0.002)	(0.002)
Log. PriceOfComp	0.010***	0.045**	0.011***	-0.003	0.008***	0.019***	0.012***	0.004***
	(0.001)	(0.018)	(0.001)	(0.015)	(0.001)	(0.002)	(0.001)	(0.001)
Log. RatByComp	-0.721***	0.399	-0.776***	-0.043	-0.696***	-1.085***	-0.823***	0.148*
	(0.061)	(0.967)	(0.067)	(1.341)	(0.067)	(0.147)	(0.078)	(0.078)
Min. Android Vers.	-0.012	-0.580***	-0.011	-0.302	-0.025**	0.039	-0.029**	0.125***
	(0.010)	(0.193)	(0.012)	(0.195)	(0.011)	(0.028)	(0.013)	(0.015)
Constant	-3.852***	-3.587*	-3.832***	-6.650***	-3.398***	-5.120***	-3.557***	-3.416***
	(0.123)	(2.124)	(0.136)	(2.355)	(0.140)	(0.306)	(0.152)	(0.172)
Category	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	176224	969	145367	771	147143	30050	128921	48272
Mean of dep. Var.	0.09	2.15	0.11	2.19	0.07	0.26	0.33	-0.50
SD of dep. Var.	1.54	2.25	1.55	2.09	1.52	1.70	1.65	1.06
Adjusted R^2	0.286	0.538	0.298	0.348	0.280	0.370	0.285	0.262

NOTES: The table shows the relationship between the presence of privacy-sensitive permissions and app demand for subsamples of our data. App demand is measured by the log. number of monthly new ratings of an app. Columns 1 and 2 split the sample into apps which are from a top developer (according to Google's classification) or not. Columns 3 and 4 split the sample into normal apps and games. Columns 5 and 6 split them into normal apps and games. Columns 7 and 8 split the sample into free and paid apps. All specifications control for the number of unproblematic permissions ($\#CleanPerm.$). Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table B5: Moderating Factors (Alternative Specifications)

	Reputation				User Groups			Visibility
Log. $\Delta Ratings$	TopDev	Installs.	Priv. Policy	Alexa	Maturity	Games	Med&Health	Warning
$D_{Privacy}$	-0.067***	-0.077***	-0.079***	-0.058***	-0.051***	-0.131***	-0.058***	-0.032***
	(0.009)	(0.008)	(0.009)	(0.010)	(0.010)	(0.010)	(0.009)	(0.010)
$D_{Privacy} \times D_{TopDev}$	0.303***							
	(0.116)							
$D_{Privacy} \times D_{NumInst}$		0.101***						
		(0.025)						
$D_{NumInst}$		2.530***						
		(0.019)						
$D_{Privacy} \times D_{Transp}$			0.397***					
			(0.041)					
D_{Transp}			0.291***					
			(0.030)					
$D_{Privacy} \times D_{AlexaRank}$				0.613***				
				(0.133)				
$D_{AlexaRank}$				0.926***				
				(0.099)				
$D_{Privacy} \times D_{Maturity}$					-0.070***			
					(0.018)			
$D_{Maturity}$					0.105***			
					(0.017)			
$D_{Privacy} \times D_{Game}$						0.318***		
						(0.019)		
D_{Game}						-0.635***		
						(0.055)		
$D_{Privacy} \times D_{MedHealth}$							-0.181***	
							(0.032)	
$D_{MedHealth}$							-0.055**	
							(0.028)	
$D_{Privacy} \times D_{Google}$								-0.084***
								(0.012)
$\#_{CleanPerm}$	0.037***	0.029***	0.035***	0.035***	0.036***	0.039***	0.036***	0.040***
	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
$D_{Internet}$	-0.200***	-0.141***	-0.198***	-0.186***	-0.199***	-0.206***	-0.200***	-0.205***
	(0.009)	(0.008)	(0.009)	(0.010)	(0.009)	(0.009)	(0.009)	(0.009)
D_{Ads}	0.235***	0.204***	0.232***	0.224***	0.235***	0.233***	0.236***	0.229***
	(0.009)	(0.008)	(0.009)	(0.010)	(0.009)	(0.009)	(0.009)	(0.009)
Log. Price	-0.071***	-0.049***	-0.071***	-0.071***	-0.071***	-0.071***	-0.071***	-0.071***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
D_{TopDev}	0.962***	0.550***	1.047***	0.904***	1.139***	1.139***	1.151***	1.138***
	(0.091)	(0.047)	(0.058)	(0.064)	(0.058)	(0.058)	(0.058)	(0.058)
D_{Other}	0.052***	0.057***	0.052***	0.071***	0.051***	0.055***	0.052***	0.052***
	(0.009)	(0.008)	(0.009)	(0.010)	(0.009)	(0.009)	(0.009)	(0.009)
Log. Length Desc.	0.263***	0.209***	0.256***	0.278***	0.262***	0.261***	0.262***	0.262***
	(0.004)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Log. Size (in KB)	0.063***	0.047***	0.061***	0.062***	0.062***	0.063***	0.063***	0.062***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Number Screenshots	0.085***	0.076***	0.082***	0.084***	0.085***	0.085***	0.085***	0.085***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Dummy: Video	0.204***	0.155***	0.186***	0.193***	0.205***	0.191***	0.204***	0.203***
	(0.012)	(0.011)	(0.012)	(0.013)	(0.012)	(0.012)	(0.012)	(0.012)
Log. Average Rating	0.199***	0.173***	0.199***	0.203***	0.199***	0.194***	0.199***	0.199***
	(0.007)	(0.006)	(0.007)	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)
App Version	0.029***	0.004	0.027***	0.032***	0.028***	0.029***	0.029***	0.028***
	(0.004)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Log. AppsByDev	-0.114***	-0.096***	-0.113***	-0.110***	-0.113***	-0.118***	-0.114***	-0.113***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Log. InstByDev	0.184***	0.121***	0.181***	0.187***	0.184***	0.183***	0.184***	0.183***
	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Log. InstByComp	-0.007***	-0.020***	-0.006***	-0.008***	-0.007***	-0.007***	-0.007***	-0.007***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Log. PriceOfComp	0.011***	0.000	0.011***	0.011***	0.011***	0.010***	0.011***	0.011***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Log. RatByComp	-0.703***	-0.198***	-0.705***	-0.776***	-0.702***	-0.752***	-0.707***	-0.706***
	(0.061)	(0.053)	(0.061)	(0.067)	(0.061)	(0.061)	(0.061)	(0.061)
Min. Android Vers.	-0.015	0.106***	-0.013	-0.015	-0.015	-0.010	-0.015	-0.014
	(0.010)	(0.009)	(0.010)	(0.012)	(0.010)	(0.010)	(0.010)	(0.010)
Max. Android Vers.	0.170***	0.158***	0.167***	0.168***	0.170***	0.170***	0.169***	0.170***
	(0.020)	(0.017)	(0.020)	(0.022)	(0.020)	(0.020)	(0.020)	(0.020)
Constant	-3.879***	-3.686***	-3.791***	-3.844***	-3.882***	-3.257***	-3.872***	-3.884***
	(0.122)	(0.104)	(0.122)	(0.136)	(0.122)	(0.132)	(0.122)	(0.122)
Category	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	177193	177193	177193	146138	177193	177193	177193	177193
Interaction	0.236	0.024	0.317	0.555	0.054	0.187	-0.239	-0.116
SE of Interaction	0.116	0.025	0.042	0.133	0.021	0.018	0.032	0.012
Mean of dep. Var.	0.10	0.10	0.10	0.12	0.10	0.10	0.10	0.10
SD of dep. Var.	1.55	1.55	1.55	1.56	1.55	1.55	1.55	1.55
Adjusted R^2	0.294	0.459	0.298	0.304	0.294	0.295	0.294	0.294

Notes: This table analyzes factors that moderate the relationship between privacy-sensitive permissions and app demand. In each specification we add interaction-terms to analyze the moderating role of reputation and user groups. Columns 1-4 analyze measures of developer or app reputation/success, whereas columns 5-7 analyze the role of user groups. The dependent variable is demand measured by the log. number of monthly new ratings of an app. Column 1 adds an interaction of privacy-sensitiveness with a dummy for 'top developers' (measured by a badge, awarded by Google). Column 2 adds an interaction and a dummy which is equal to one if the app had accumulated 75000 or more installations since its market entry. Column 3 adds an interaction and a dummy which is equal to one if the app is transparant about its origin and privacy policy, i.e. if it has published a privacy policy, email and website address that are directly accessible from the Play Store. Column 4 adds an interaction and dummy which is equal to one if the app has a high ranking on Alexa.com, i.e. its website traffic rank is lower than 10000. Column 5 uses a dummy which is equal to one if the app is a high maturity app, i.e. if it requires medium or high maturity or is not rated at all. In Column 6 it is equal to one if the app is a game. Column 7 contains a dummy which is equal to one if the app is a health or medical app. In Column 8 we use a interaction term which is equal to one if the app uses at least one privacy-sensitive permission and one permission for which Google provides in its permission description a warning, which states that a malicious app with this permission could create harm to the user. All specifications control for the app's observed characteristics on the Play Store (the app's price, description, ratings, categorical dummies, etc.), and also control for internet access, and ad-specific permissions as well as unproblematic permissions. Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

2.3 Main Estimation Tables - Detailed Version

Table B6: Main Supply Side Results

	Business Model Choice (D_{Paid})						Price Choice (Log. Price)			
	Cross-Section		Panel		Pairs		Cross-Section		Panel	
$D_{Privacy}$	-0.033***		-0.104		-0.156***		0.012		-0.119*	
	(0.002)		(0.261)		(0.042)		(0.008)		(0.070)	
$\#_{Privacy}$		-0.024***		-0.150*		-0.137***		-0.005		-0.060**
		(0.001)		(0.086)		(0.025)		(0.004)		(0.025)
$\#_{CleanPerm}$	0.005***	0.011***	-0.003	0.035	0.204***	0.226***	0.018***	0.020***	0.048**	0.068***
	(0.001)	(0.001)	(0.024)	(0.030)	(0.023)	(0.025)	(0.002)	(0.002)	(0.020)	(0.023)
$D_{Internet}$	-0.219***	-0.225***	-0.627**	-0.582**	-0.496***	-0.517***	0.067***	0.068***	0.004	-0.015
	(0.003)	(0.003)	(0.290)	(0.246)	(0.037)	(0.038)	(0.007)	(0.007)	(0.085)	(0.083)
D_{Ads}	-0.119***	-0.124***	-0.347	-0.165	-0.535***	-0.547***	0.014	0.014	-0.003	-0.039
	(0.002)	(0.002)	(0.301)	(0.250)	(0.036)	(0.036)	(0.009)	(0.009)	(0.119)	(0.112)
D_{Other}	0.010***	0.009***	0.363***	0.546***	-0.153**	-0.155**	0.119***	0.121***	-0.015	-0.009
	(0.002)	(0.002)	(0.110)	(0.139)	(0.068)	(0.067)	(0.008)	(0.007)	(0.076)	(0.077)
Log. Length Desc.	0.054***	0.054***	0.133	0.124	-0.607***	-0.601***	0.079***	0.079***	0.160**	0.133**
	(0.001)	(0.001)	(0.092)	(0.111)	(0.203)	(0.201)	(0.004)	(0.004)	(0.069)	(0.064)
Log. Size (in KB)	0.032***	0.031***	-0.591***	-0.605***	-0.186***	-0.177***	0.017***	0.017***	0.040	0.045
	(0.001)	(0.001)	(0.187)	(0.154)	(0.037)	(0.037)	(0.002)	(0.002)	(0.033)	(0.033)
Number Screenshots	0.011***	0.011***	0.111***	0.131***	0.063***	0.062***	0.008***	0.008***	0.040*	0.038*
	(0.001)	(0.001)	(0.035)	(0.041)	(0.015)	(0.015)	(0.002)	(0.002)	(0.021)	(0.023)
Dummy: Video	-0.003	-0.002	-0.432	-0.208	0.055	0.040	0.045***	0.045***	-0.123	-0.162
	(0.003)	(0.003)	(0.282)	(0.283)	(0.120)	(0.124)	(0.008)	(0.008)	(0.112)	(0.108)
Log. Average Rating	-0.038***	-0.039***	-0.063	0.295	0.370***	0.372***	-0.021***	-0.021***	-0.036	-0.069
	(0.003)	(0.003)	(0.111)	(0.241)	(0.051)	(0.050)	(0.007)	(0.007)	(0.138)	(0.137)
Dummy: Top-Dev.	0.186***	0.184***	0.000	0.000	0.000	0.000	0.097***	0.097***	0.000	0.000
	(0.015)	(0.014)	(.)	(.)	(.)	(.)	(0.030)	(0.030)	(.)	(.)
App Version	-0.048***	-0.048***	-0.142	-0.194*	-0.192***	-0.191***	-0.014***	-0.014***	0.069	0.083*
	(0.001)	(0.001)	(0.150)	(0.109)	(0.014)	(0.014)	(0.003)	(0.003)	(0.053)	(0.049)
Log. AppsByDev	0.021***	0.022***	-1.619**	-1.236*	0.000	0.000	0.019***	0.019***	0.021	-0.008
	(0.001)	(0.001)	(0.793)	(0.693)	(.)	(.)	(0.002)	(0.002)	(0.094)	(0.094)
Log. InstByDev	-0.018***	-0.019***	-0.488***	-0.407***	0.158***	0.158***	0.010***	0.010***	0.017	0.011
	(0.000)	(0.000)	(0.120)	(0.119)	(0.005)	(0.005)	(0.001)	(0.001)	(0.022)	(0.019)
Log. InstByComp	-0.018***	-0.018***	-0.052*	-0.048	-0.023***	-0.022***	-0.016***	-0.016***	0.003	0.002
	(0.001)	(0.001)	(0.030)	(0.035)	(0.008)	(0.008)	(0.001)	(0.001)	(0.012)	(0.012)
Log. PriceOfComp	0.017***	0.017***	-0.001	0.002	0.007**	0.007***	0.008***	0.008***	0.003	0.002
	(0.000)	(0.000)	(0.007)	(0.006)	(0.003)	(0.003)	(0.001)	(0.001)	(0.012)	(0.011)
Log. RatByComp	0.189***	0.188***	-0.147	-0.450	1.344***	1.351***	-0.526***	-0.531***	0.331	0.566
	(0.017)	(0.017)	(0.409)	(0.390)	(0.228)	(0.227)	(0.048)	(0.048)	(0.448)	(0.430)
Min. Android Vers.	-0.045***	-0.045***	-1.124***	-1.262***	-0.229	-0.191	-0.061***	-0.061***	0.057	0.126
	(0.003)	(0.003)	(0.238)	(0.229)	(0.160)	(0.147)	(0.008)	(0.008)	(0.153)	(0.138)
Max. Android Vers.	0.026***	0.026***	1.371***	1.135***	-0.256	-0.260	0.040**	0.039**	0.264***	0.291***
	(0.006)	(0.006)	(0.380)	(0.319)	(0.176)	(0.177)	(0.019)	(0.019)	(0.053)	(0.052)
Constant	0.094***	0.090**	10.787***	9.913***	3.495**	3.291**	0.060	0.065	-2.943***	-3.558***
	(0.035)	(0.035)	(2.840)	(2.754)	(1.533)	(1.520)	(0.106)	(0.106)	(0.870)	(0.835)
Category	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Observations	176000	176000	96	96	3998	3998	47079	47079	422	422
Num. of Groups			48	48	1999	1999			211	211
Mean of dep. Var.	0.27	0.27	0.50	0.50	0.50	0.50	0.20	0.20	0.53	0.53
SD of dep. Var.	0.44	0.44	0.50	0.50	0.50	0.50	0.60	0.60	0.62	0.62
Adjusted R^2	0.320	0.322	0.963	0.971	0.618	0.622	0.223	0.223	0.177	0.183

NOTES: The table shows the relationship between privacy-sensitive permissions and the strategic choices of app developers: the choice of the business model in Columns 1-6, and the price choice in Columns 7-10. In Columns 1-6 the dependent variable D_{Paid} measures the developer's decision to offer their app for money or for free. It takes the value 1 if users have to pay to download the app. Columns 1 and 2 show descriptive regressions based on the cross-section of data, where the independent variable of interest is (1) an indicator for one or more privacy-sensitive permissions ($D_{Privacy}$ in Column 1) or (2) the number of privacy-sensitive permissions ($\#Privacy$ in Column 2). Columns 3 and 4 show panel fixed effects regressions where we restrict the sample to such apps which changed both the number of privacy-sensitive permissions and the business model at least once between April and September 2012. Columns 5 and 6 use data on app-pairs where the paid version of the app has the same or a smaller code size and where both apps have more or less the same description length. Columns 7-10 show the results for price-level choices (of paid apps). The dependent variable is the app's price (in logs). Columns 7 and 8 show cross sectional regressions, and Columns 9 and 10 show panel fixed effects regressions where we restrict the sample to such apps which change both the number of privacy-sensitive permissions and their price at least once. In all specifications we drop outliers with respect to app prices, i.e. apps with prices above 8 Euros. All of these regressions control for the number of clean permissions and permissions that are needed to show ads. Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table B7: Main Demand Side Results

	Cross-Section (Log.$\Delta Ratings$)			Panel (Log.$\Delta Ratings$)		Difference-in-Difference	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$D_{Privacy}$	0.012	-0.065***		-0.059***		-12.660*	-14.988**
	(0.011)	(0.009)		(0.020)		(6.634)	(7.215)
$\#_{Privacy}$			-0.021***		-0.014**		
			(0.003)		(0.007)		
$\#_{CleanPerm}$	0.111***	0.037***	0.041***	-0.010**	-0.005	0.849	1.011*
	(0.004)	(0.003)	(0.003)	(0.005)	(0.005)	(0.643)	(0.605)
$D_{Internet}$		-0.200***	-0.211***	0.003	-0.014		
		(0.009)	(0.009)	(0.054)	(0.053)		
D_{Ads}		0.236***	0.230***	0.002	-0.014		
		(0.009)	(0.009)	(0.033)	(0.033)		
Log. Price		-0.071***	-0.071***	-0.044***	-0.043***		
		(0.001)	(0.001)	(0.011)	(0.011)		
D_{Other}		0.052***	0.045***	0.022	0.024		
		(0.009)	(0.009)	(0.022)	(0.022)		
Log. Length Desc.		0.263***	0.262***	0.003	0.002		
		(0.004)	(0.004)	(0.023)	(0.023)		
Log. Size (in KB)		0.063***	0.062***	0.044***	0.043***		
		(0.002)	(0.002)	(0.017)	(0.017)		
Number Screenshots		0.085***	0.085***	0.029**	0.027**		
		(0.002)	(0.002)	(0.011)	(0.011)		
Dummy: Video		0.204***	0.204***	-0.138**	-0.139**		
		(0.012)	(0.012)	(0.058)	(0.059)		
Log. Average Rating		0.198***	0.199***	0.267***	0.272***		
		(0.007)	(0.007)	(0.098)	(0.098)		
Dummy: Top-Dev.		1.139***	1.136***	-0.206***	-0.179***		
		(0.058)	(0.058)	(0.016)	(0.014)		
App Version		0.029***	0.028***	0.029*	0.032**		
		(0.004)	(0.004)	(0.015)	(0.015)		
Log. AppsByDev		-0.114***	-0.114***	-0.161***	-0.157***		
		(0.002)	(0.002)	(0.029)	(0.029)		
Log. InstByDev		0.184***	0.183***	-0.011	-0.011		
		(0.002)	(0.002)	(0.014)	(0.014)		
Log. InstByComp		-0.007***	-0.007***	0.004	0.004		
		(0.002)	(0.002)	(0.004)	(0.004)		
Log. PriceOfComp		0.011***	0.011***	-0.001	-0.001		
		(0.001)	(0.001)	(0.001)	(0.001)		
Log. RatByComp		-0.707***	-0.703***	-0.030	-0.031		
		(0.061)	(0.061)	(0.129)	(0.129)		
Min. Android Vers.		-0.015	-0.014	0.058	0.056		
		(0.010)	(0.010)	(0.044)	(0.044)		
Max. Android Vers.		0.170***	0.170***	-0.143	-0.137		
		(0.020)	(0.020)	(0.096)	(0.097)		
Constant	-0.289***	-3.871***	-3.872***	1.198**	1.201**	4.262	2.428
	(0.007)	(0.122)	(0.122)	(0.561)	(0.563)	(5.735)	(6.327)
Category	No	Yes	Yes	Yes	Yes	No	No
Month	No	No	No	Yes	Yes	No	No
Observations	177193	177193	177193	33095	33095	192	162
Num. of Groups				6619	6619		
Mean of dep. Var.	0.10	0.10	0.10	1.63	1.63	-0.24	-3.22
SD of dep. Var.	1.55	1.55	1.55	2.23	2.23	31.81	29.27
Adjusted R^2	0.047	0.294	0.294	0.033	0.033	0.013	0.025

Notes: The table shows the relationship between the presence of privacy-sensitive permissions and app demand on three different data sets: Columns 1-5 exploit our cross-section and panel data; Columns 6-7 show a difference-in-differences style setup between Google's Play Store and the iOS App Store. In Columns 1-5 the dependent variable is demand proxied by the log. number of monthly new ratings of an app. Columns 1-3 contain cross-section results. Column 1 shows the raw correlation between the use of privacy-sensitive permissions and demand. Column 2 adds in controls for the app's observed characteristics. Column 3 uses the number of privacy-sensitive permissions as privacy indicator. Columns 4-5 show panel fixed effects regressions for those apps within our data set that varied their use of privacy-sensitive permissions at least once between April and September 2012. We show the results for the presence of privacy-sensitive permissions (Column 4) and their number (Column 5). In Columns 6 and 7 the dependent variable is the difference between the app's download ranks on the iOS App Store vs. Google Play Store. In Column 6 this difference is based on the average download ranks of seven countries, whereas in Column 7 it is based only on US ranks. All specifications control for the number of unproblematic permissions ($\#CleanPerm.$). Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table B8: Moderating Factors of the Demand Side Relationship

	Top Apps		Privacy Policy		Maturity Level		Med.&Health Apps	
Log. $\Delta Ratings$	Low	High	No	Yes	High	Low	Yes	No
$D_{Privacy}$	-0.068***	0.008	-0.070***	0.038	-0.109***	-0.054***	-0.151***	-0.060***
	(0.008)	(0.029)	(0.009)	(0.057)	(0.019)	(0.010)	(0.043)	(0.009)
$\#_{CleanPerm}$	0.029***	0.014***	0.033***	0.054***	0.028***	0.038***	0.029**	0.036***
	(0.002)	(0.005)	(0.003)	(0.010)	(0.008)	(0.003)	(0.014)	(0.003)
$D_{Internet}$	-0.122***	-0.320***	-0.192***	-0.254***	-0.108***	-0.211***	-0.106**	-0.203***
	(0.008)	(0.040)	(0.009)	(0.063)	(0.019)	(0.010)	(0.041)	(0.009)
D_{Ads}	0.188***	0.364***	0.229***	0.225***	0.292***	0.222***	0.180***	0.238***
	(0.008)	(0.033)	(0.009)	(0.056)	(0.025)	(0.010)	(0.042)	(0.009)
Log. Price	-0.048***	0.003	-0.070***	-0.114***	-0.050***	-0.076***	-0.056***	-0.072***
	(0.001)	(0.007)	(0.001)	(0.005)	(0.002)	(0.001)	(0.003)	(0.001)
D_{Other}	0.047***	0.122***	0.050***	0.067	0.116***	0.040***	0.057	0.053***
	(0.008)	(0.028)	(0.009)	(0.052)	(0.025)	(0.010)	(0.044)	(0.009)
Log. Length Desc.	0.202***	0.275***	0.252***	0.404***	0.237***	0.268***	0.257***	0.262***
	(0.003)	(0.016)	(0.004)	(0.027)	(0.011)	(0.004)	(0.018)	(0.004)
Log. Size (in KB)	0.044***	0.093***	0.061***	0.065***	0.044***	0.065***	0.064***	0.062***
	(0.002)	(0.009)	(0.002)	(0.015)	(0.005)	(0.002)	(0.010)	(0.002)
Number Screenshots	0.073***	0.071***	0.083***	0.076***	0.086***	0.084***	0.075***	0.085***
	(0.002)	(0.006)	(0.002)	(0.012)	(0.007)	(0.002)	(0.010)	(0.002)
Dummy: Video	0.151***	0.083**	0.181***	0.250***	0.072*	0.218***	0.024	0.208***
	(0.011)	(0.033)	(0.012)	(0.050)	(0.039)	(0.013)	(0.068)	(0.012)
Log. Average Rating	0.155***	2.242***	0.200***	0.192***	0.207***	0.204***	0.257***	0.196***
	(0.006)	(0.102)	(0.007)	(0.072)	(0.014)	(0.008)	(0.029)	(0.007)
Dummy: Top-Dev.	0.588***	0.333***	1.143***	0.614***	1.505***	1.104***	0.155	1.272***
	(0.063)	(0.070)	(0.066)	(0.130)	(0.212)	(0.060)	(0.126)	(0.063)
App Version	0.010***	-0.066***	0.028***	-0.012	0.018*	0.032***	0.069***	0.027***
	(0.003)	(0.015)	(0.004)	(0.026)	(0.010)	(0.004)	(0.020)	(0.004)
Log. AppsByDev	-0.097***	-0.085***	-0.112***	-0.173***	-0.077***	-0.122***	-0.100***	-0.114***
	(0.002)	(0.010)	(0.002)	(0.018)	(0.004)	(0.002)	(0.010)	(0.002)
Log. InstByDev	0.124***	0.099***	0.178***	0.289***	0.140***	0.192***	0.164***	0.184***
	(0.001)	(0.006)	(0.002)	(0.010)	(0.004)	(0.002)	(0.008)	(0.002)
Log. InstByComp	-0.022***	0.039***	-0.009***	0.013	-0.007*	-0.007***	0.009	-0.007***
	(0.002)	(0.008)	(0.002)	(0.011)	(0.004)	(0.002)	(0.011)	(0.002)
Log. PriceOfComp	-0.002**	0.024***	0.010***	0.031***	0.007***	0.011***	0.013***	0.011***
	(0.001)	(0.003)	(0.001)	(0.005)	(0.002)	(0.001)	(0.004)	(0.001)
Log. RatByComp	-0.273***	-0.181	-0.685***	-1.048***	-0.424***	-0.761***	-0.765**	-0.716***
	(0.055)	(0.199)	(0.061)	(0.358)	(0.134)	(0.068)	(0.304)	(0.062)
Min. Android Vers.	0.094***	0.371***	-0.012	-0.026	-0.022	-0.011	-0.076	-0.014
	(0.009)	(0.040)	(0.010)	(0.069)	(0.026)	(0.011)	(0.051)	(0.011)
Max. Android Vers.	0.159***	0.112	0.172***	0.028	0.187***	0.171***	0.146	0.171***
	(0.017)	(0.095)	(0.019)	(0.196)	(0.032)	(0.023)	(0.127)	(0.020)
Constant	-3.470***	-4.694***	-3.753***	-4.497***	-3.467***	-3.980***	-3.811***	-3.865***
	(0.106)	(0.499)	(0.122)	(0.976)	(0.247)	(0.140)	(0.669)	(0.125)
Category	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	164157	13036	170658	6535	27843	149350	6218	170975
Mean of dep. Var.	-0.14	3.16	0.06	1.11	-0.18	0.15	-0.08	0.11
SD of dep. Var.	1.27	1.54	1.52	2.02	1.38	1.58	1.38	1.56
Adjusted R^2	0.221	0.293	0.285	0.371	0.305	0.291	0.270	0.295

NOTES: The table shows the relationship between the presence of privacy-sensitive permissions and app demand for subsamples of our data. App demand is measured by the log. number of monthly new ratings of an app. Columns 1 and 2 split the sample into apps which have a high or a low stock of installations (more or less than 75000 installations). Columns 3 and 4 split the sample into apps with and without a privacy policy. Columns 5 and 6 split them into apps which require a high (Column 5) or low (Column 6) maturity of the user (apps are defined as appropriate for low maturity if they classified as being recommended for 'everyone' or for 'low maturity'-users). Columns 7 and 8 split the sample into medical and health-related apps as well as into other apps. All specifications control for the number of unproblematic permissions ($\#CleanPerm.$). Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

2.4 Robustness Checks - Detailed Version

This section provides more detailed descriptions of our robustness checks. It fills in the descriptive details that we had to omit for the brief presentation in the paper's main body in order to save space.

2.4.1 Supply-side Analysis: Privacy Definition and Including Moderating Factors

In Table B9, we analyze the robustness of our supply-side findings to using alternative definitions of privacy, to including moderating factors and the use of alternative samples.

The table shows additional supply-side results for the developer's choice of their business model. The dependent variable is the developer's decision to offer their app for money or for free (D_{Paid}). All specifications, except those using the pairs data set, use the cross section data from April 2012. Column 1 uses as privacy measure an individual dummy for each number of privacy-sensitive permissions (1, 2 or 3 and more permissions). Column 2 uses a cross term equal to one for apps which simultaneously use sensitive permissions and have access to the internet. Columns 3 and 4 split the sample into normal apps (Col. 3) and games (Col. 4). Column 5 adds a cross term for apps with a very large total number of installations (10000 or more). Column 6 adds a cross term for apps that could be associated with a top-ranked website (on Alexa.com), i.e. for a website with rank lower than 10000. Columns 7 and 8 analyze the most restrictive set of matched pairs (no difference in description or only difference describes existence of ads, verified by human coders). In all specifications we drop outliers with respect to app prices, i.e. apps with prices above 8 Euros. All of these regressions control for the number of clean permissions and permissions that are needed to show ads.

In columns 1-4, we varied the specification in the supply-side regressions to verify (i) that our results do not depend on our privacy variable, and (ii) that they hold within subsamples of our data, such as games and normal apps. The results show that our main cross section results do not depend on the choice of the specific privacy measure. Apps that request more privacy-sensitive permissions are more likely to be free (column 1). Column 2 shows that developers strategically use privacy-sensitive permissions in free apps only together with internet access. This highlights that data collection (via permissions) is more valuable for developers if they can easily transfer the data from the app (via internet access). Columns 3 and 4 show that our baseline finding holds for both non-game apps (column 3) and games (column 4). For both groups, we find a negative significant effect.

Also, our supply-side results are robust to including moderating factors and to the use of a more rigorous matched set of app pairs: In columns 5-8, we analyze the role of moderating factors on the supply side and restrict the pairs data set even further to rule out unobserved heterogeneity as an explanation of our results. Columns 5 and 6 show that the role of reputation as a moderating factor is equally important for the supply side as for the demand side. In column 5 we separately analyze apps with a large user base, and in column 6 we analyze apps that are associated with a popular website (low traffic rank on Alexa.com). Such apps are generally less likely to be paid versions, but if they are paid, they are more likely to require privacy-sensitive permissions. Columns 7 and 8 analyze the robustness of our supply-side results, which we obtained based on the app pairs data

set by applying a more restrictive matching for the pairs data: here we only consider pairs with no difference in description and code length, which was verified by human coders. These results show again that privacy-sensitive permissions are more likely in free apps, independently of how restrictive we are in our matching of the app pairs. Taken together, these results confirm our baseline findings for the supply side of the market.

2.4.2 Panel estimations are robust to using alternative samples and specifications:

Beyond the panel specifications in Table B7 we run additional fixed-effect panel regressions. We thus verfiy the robustness of our panel results to using alternative specifications. The results are shown in Table B10.

Our demand side panel data set consists of apps which we observed in each of the five waves between April and September 2012 and that varied their use of privacy-sensitive permissions at least once in this period. In columns 3 and 6 we restrict our sample in addition to apps which did not change the length of the app's description in the Google Play Store during this period. We interpret such a change in permission without a change in the app's description as an indication of a change in permissions which came without a change in functionality.

The dependent variable is the log. number of monthly new ratings of an app. Columns 1-3 analyze the effect of introducing any privacy-sensitive permissions (measured by the indicator, whereas Columns 4-6 use the number of privacy-sensitive permissions as the variable of interest. In all specifications we include monthly fixed-effects and control for the number of unproblematic permissions. We first analyzed the raw fixed effects regressions without controls (Columns 1 and 4), and then we added control variables and dummies to control for the apps' categories. (Columns 2 and 5). Finally we analyze our reduced sample of apps that introduced new permissions without changing their description (Columns 3 and 6).

The estimated coefficient of interest remains essentially unchanged when looking at the specification in column 1 where we include only a reduced set of controls, or when we restrict the data to apps that introduced permissions but no major update to functionality (column 3). Moreover, we see similar results when analyzing the number of sensitive permissions, rather than an indicator for their presence (cols. 4-6).

Table B9: Alternative Supply Side Results

	Privacy Measures				Non-Games vs Games		Moderating Factors		App Pairs	
D_{Paid}	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\#_{Privacy=1}$	-0.010***									
	(0.003)									
$\#_{Privacy=2}$	-0.058***									
	(0.003)									
$\#_{Privacy\geq 3}$	-0.111***									
	(0.004)									
$D_{Privacy}$		0.012*			-0.012***	-0.057***	-0.062***	-0.037***	-0.246***	
		(0.006)			(0.003)	(0.005)	(0.003)	(0.003)	(0.054)	
$D_{Privacy} \times D_{Internet}$		-0.055***								
		(0.007)								
$D_{PrivCatSpec}$			-0.102***							
			(0.003)							
$\#_{PrivCatSpec}$				-0.045***						
				(0.001)						
$D_{Privacy} \times D_{NumInst}$							0.144***			
							(0.003)			
$D_{NumInst}$							-0.322***			
							(0.003)			
$D_{Privacy} \times D_{AlexaRank}$								0.046**		
								(0.018)		
$D_{AlexaRank}$								-0.109***		
								(0.016)		
$\#_{Privacy}$										-0.199***
										(0.029)
$\#_{CleanPerm}$	0.009***	0.005***	0.006***	0.008***	0.003***	0.012***	0.005***	0.004***	0.031	0.051**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.024)	(0.025)
$D_{Internet}$	-0.223***	-0.209***	-0.216***	-0.220***	-0.206***	-0.221***	-0.209***	-0.217***	-0.392***	-0.422***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.008)	(0.003)	(0.003)	(0.047)	(0.047)
D_{Ads}	-0.122***	-0.117***	-0.120***	-0.120***	-0.127***	-0.139***	-0.106***	-0.114***	-0.522***	-0.531***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.006)	(0.002)	(0.003)	(0.051)	(0.048)
D_{Other}	0.013***	0.009***	0.013***	0.012***	0.004	-0.004	0.011***	0.014***	-0.023	-0.015
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.007)	(0.002)	(0.003)	(0.091)	(0.088)
Log. Length Desc.	0.054***	0.054***	0.053***	0.053***	0.058***	0.033***	0.061***	0.054***	0.006	0.004
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.001)	(0.001)	(0.050)	(0.051)
Log. Size (in KB)	0.032***	0.032***	0.031***	0.030***	0.026***	0.045***	0.032***	0.030***	-0.014	-0.026
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.029)	(0.030)
Number Screenshots	0.011***	0.011***	0.011***	0.011***	0.012***	0.011***	0.012***	0.012***	0.029	0.028
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.020)	(0.019)
Dummy: Video	0.000	-0.003	-0.001	-0.003	0.027***	0.014**	0.006**	-0.001	-0.422**	-0.401**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.007)	(0.003)	(0.004)	(0.192)	(0.184)
Log. Average Rating	-0.038***	-0.037***	-0.036***	-0.037***	-0.050***	0.065***	-0.033***	-0.036***	0.122	0.118
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.008)	(0.003)	(0.003)	(0.079)	(0.073)
Dummy: Top-Dev.	0.184***	0.186***	0.177***	0.178***	0.118***	0.217***	0.223***	0.201***	0.000	0.000
	(0.014)	(0.015)	(0.014)	(0.014)	(0.016)	(0.025)	(0.014)	(0.015)	(.)	(.)
App Version	-0.048***	-0.048***	-0.049***	-0.049***	-0.048***	-0.065***	-0.040***	-0.044***	-0.041*	-0.022
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.001)	(0.001)	(0.024)	(0.025)
Log. AppsByDev	0.022***	0.022***	0.023***	0.023***	0.034***	-0.020***	0.016***	0.019***	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(.)	(.)
Log. InstByDev	-0.019***	-0.018***	-0.018***	-0.019***	-0.025***	0.010***	-0.005***	-0.018***	0.062***	0.059***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.009)	(0.009)
Log. InstByComp	-0.017***	-0.018***	-0.017***	-0.018***	-0.016***	-0.021***	-0.015***	-0.018***	-0.003	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.013)	(0.012)
Log. PriceOfComp	0.017***	0.017***	0.017***	0.017***	0.017***	0.012***	0.017***	0.017***	-0.005	-0.004
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.004)	(0.004)
Log. RatByComp	0.190***	0.190***	0.196***	0.195***	0.291***	0.004	0.103***	0.199***	0.628*	0.498
	(0.017)	(0.017)	(0.017)	(0.017)	(0.019)	(0.039)	(0.016)	(0.019)	(0.337)	(0.324)
Min. Android Vers.	-0.044***	-0.046***	-0.045***	-0.043***	-0.052***	-0.035***	-0.065***	-0.042***	-0.034	-0.074
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.008)	(0.003)	(0.003)	(0.167)	(0.163)
Max. Android Vers.	0.025***	0.027***	0.025***	0.027***	0.025***	0.023	0.025***	0.016**	0.000	0.000
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.017)	(0.006)	(0.007)	(.)	(.)
Constant	0.081**	0.085**	0.080**	0.087**	-0.067*	0.087	0.127***	0.133***	-0.411	-0.167
	(0.035)	(0.035)	(0.035)	(0.035)	(0.040)	(0.088)	(0.034)	(0.039)	(0.687)	(0.667)
Category	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	176000	176000	176000	176000	145972	30028	176000	145126	708	708
Num. of Groups	0.27	0.27	0.27	0.27	0.28	0.23	0.27	0.27	0.50	0.50
Mean of dep. Var.	0.44	0.44	0.44	0.44	0.45	0.42	0.44	0.44	0.50	0.50
SD of dep. Var.	0.323	0.320	0.324	0.324	0.348	0.260	0.367	0.319	0.848	0.862

Notes: The table shows additional supply-side results for the developer's choice of their business model. The dependent variable is the developer's decision to offer their app for money or for free (D_{Paid}). Column 1 uses as privacy measure an individual dummy for each number of privacy-sensitive permissions (1, 2 or 3 and more permissions). Column 2 uses a cross term equal to one for apps which simultaneously use sensitive permissions and have access to the internet. Columns 3 and 4 use our category-specfic privacy measures. Within a category we flag a privacy-sensitive permission as problematic only if paid apps of this category use this permission on average less often than the overall average paid app. Columns 5 and 6 split the sample into normal apps (Col. 5) and games (Col. 6). Column 7 adds a cross term for apps with a very large total number of installations (10000 or more). Column 8 adds a cross term for apps that could be associated with a top-ranked website (on Alexa.com), i.e. for a website with rank lower than 10000. Columns 9 and 10 analyze the most restrictive set of matched pairs (no difference in description or only difference describes existence of ads, verified by human coders). In all specifications we drop outliers with respect to app prices, i.e. apps with prices above 8 Euros. All of these regressions control for the number of clean permissions and permissions that are needed to show ads. Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table B10: Alternative Panel Demand Side Estimation Results

Log. $\Delta Ratings$	(1)	(2)	(3)	(4)	(5)	(6)
$D_{Privacy}$	-0.070***	-0.059***	-0.063**			
	(0.020)	(0.020)	(0.027)			
$\#_{Privacy}$				-0.023***	-0.014**	-0.010
				(0.006)	(0.007)	(0.009)
$\#_{CleanPerm}$	-0.010**	-0.010**	-0.003	-0.000	-0.005	-0.001
	(0.004)	(0.005)	(0.006)	(0.005)	(0.005)	(0.007)
$D_{Internet}$	-0.003	0.003	0.033	-0.021	-0.014	0.012
	(0.054)	(0.054)	(0.072)	(0.054)	(0.053)	(0.071)
D_{Ads}	0.007	0.002	-0.041	-0.011	-0.014	-0.058
	(0.033)	(0.033)	(0.043)	(0.032)	(0.033)	(0.043)
Log. Price	-0.044***	-0.044***	-0.037***	-0.044***	-0.043***	-0.037***
	(0.011)	(0.011)	(0.013)	(0.011)	(0.011)	(0.013)
D_{Other}		0.022			0.024	
		(0.022)			(0.022)	
Log. Length Desc.		0.003			0.002	
		(0.023)			(0.023)	
Log. Size (in KB)		0.044***			0.043***	
		(0.017)			(0.017)	
Number Screenshots		0.029**			0.027**	
		(0.011)			(0.011)	
Dummy: Video		-0.138**			-0.139**	
		(0.058)			(0.059)	
Log. Average Rating		0.267***			0.272***	
		(0.098)			(0.098)	
Dummy: Top-Dev.		-0.206***			-0.179***	
		(0.016)			(0.014)	
App Version		0.029*			0.032**	
		(0.015)			(0.015)	
Log. AppsByDev		-0.161***			-0.157***	
		(0.029)			(0.029)	
Log. InstByDev		-0.011			-0.011	
		(0.014)			(0.014)	
Log. InstByComp		0.004			0.004	
		(0.004)			(0.004)	
Log. PriceOfComp		-0.001			-0.001	
		(0.001)			(0.001)	
Log. RatByComp		-0.030			-0.031	
		(0.129)			(0.129)	
Min. Android Vers.		0.058			0.056	
		(0.044)			(0.044)	
Max. Android Vers.		-0.143			-0.137	
		(0.096)			(0.097)	
Constant	1.158***	1.198**	0.749***	1.156***	1.201**	0.741***
	(0.127)	(0.561)	(0.154)	(0.128)	(0.563)	(0.155)
Category	No	Yes	No	No	Yes	No
Month	Yes	Yes	Yes	Yes	Yes	Yes
Observations	33095	33095	15220	33095	33095	15220
Num. of Groups	6619	6619	3044	6619	6619	3044
Mean of dep. Var.	1.63	1.63	1.17	1.63	1.63	1.17
SD of dep. Var.	2.23	2.23	2.10	2.23	2.23	2.10
Adjusted R^2	0.026	0.033	0.020	0.026	0.033	0.020

Notes: This table shows the results from fixed-effect panel regressions. The dependent variable is the log. number of monthly new ratings of an app. We restrict our sample to apps within our data set that varied their use of privacy-sensitive permissions at least once between April and September 2012. Columns 1-3 analyze the effect of introducing any privacy-sensitive permissions (measured by the indicator $D_{Privacy}$), whereas Columns 4-6 use the number of privacy-sensitive permissions as the variable of interest. Columns 1 and 4 show the raw fixed effects regressions without controls. In Columns 2 and 5 we add control variables and dummies to control for the apps' categories. Columns 3 and 6 restrict the analysis to apps that introduced new permissions without changing the app's description (no change in the length of description). In all specifications we include monthly fixed-effects and control for the number of unproblematic permissions. Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

2.4.3 Alternative Difference-in-Differences-Style Estimation Results:

Table A6 shows demand-side results from comparing the download ranks of an app in the iOS Appstore and Google's Play Store depending on whether its Android version uses privacy-sensitive permissions or not. It provides results which illustrate the robustness of our DiD-style results to the use of alternative rank measures and subsamples of the data.

Data Preparation and Additional Variables: To compare apps' relative success in the Android OS and iOS in dependence of their use of privacy-sensitive permissions, we collected in 2016 app rankings from 2012 for both OS from AppAnnie.com. We found only a small number of (mostly successful) apps for which the app ranking from 2012 was available for both OS. Unlike in our main data sets, which contain global success measures such as the world wide number of installations, rankings are only available at a country-specific basis. Thus, we collected rankings for April and September 2012 and for seven important markets: Germany, India, Japan, Korea, Russia, the UK and the US April and September 2012. For free apps we use the 'overall free app rank' and for paid apps we use the 'overall paid ranking'.[3] For the estimation sample we kept those apps for which we were able to collect at least four rankings per OS (out of the up to 14 rankings per OS).

Based on that information we construct four measures of the relative app success on the two operating systems ($\Delta Rank^{iOS-And}$):

- In column 1 of Table A6 the dependent variable is the simple difference between the iOS and the Android country ranks we were able to collect for each app, i.e. it is the difference between the average iOS rank (which is based on up to 14 country- and time-specific ranks) and the Android OS average rank.

- In column 2 the dependent variable is also a difference based on the average country ranks. However, here we construct for each OS based on the observed average ranks an in-sample ranking which ranks apps within the OS according to its average OS-specific rank. The difference between the iOS and the Android is then computed as the difference between the two self-generated in-sample ranks.[4] This procedure guarantees that the observed apps' ranks have a similar distribution in Apple's iOS and Google's Android OS.

- In column 3 the dependent variable is again a simple difference as in column 1 but is based only on the US ranks.

- In column 4 the dependent variable is also based only on US ranks but again uses the difference between self-generated rankings which we created as in column 2 for each OS.

[3] In addition to overall rankings there are also category-specific rankings such as rankings for games, weather apps, and education apps.

[4] Specifically: we compute average rankings by app and operating system based on the time- and country-specific ranks (up to seven countries and two points in time per OS, i.e. based on up to 14 ranks). Using this information we create a new in-sample ranking which ranks apps by the order of their average rank values and ranges from 1 to 192 for each operating system. The measure we use in the estimation is then the difference between the rank we have computed for the iOS version and the one we have computed for the Android version (i.e. iOS rank minus Android rank).

Columns 5 & 6 finally also use, as in column 2, the difference between the newly created ranks based on the average download ranks but split the sample into games (Column 6) and other apps (Column 5).

Results: The results show that the DiD-style comparison is robust to using alternative measures of the ranking difference: All specifications, except specification 6 which covers only games, show a significant negative effect for privacy-sensitive permissions. This corroborates the conclusion that apps that request privacy-sensitive permissions are on average less successful in the Android OS than in Apple's iOS, which could be due to the fact that only in the Android OS are these permissions visible to the user before installation of the app. These significant findings are all the more impressive given the low number of observations and the fact that our previous results suggest a lower effect for privacy-sensitive permissions of well-known apps.[5] Also, the insignificant effect for games is in line with our main results which show that a weaker or even an insignificant relationship between privacy-sensitive permissions and demand exists for games. Thus, the results reaffirm our baseline demand results as well as the results shown in our analysis of moderating factors despite using a completely different sample of apps and using a completely different identification approach.

Table B11: Alternative Difference-in-Differences-Style Estimation Results:

	Global Ranks		US Ranks		Non-Games vs Games	
	(1)	(2)	(3)	(4)	(5)	(6)
$D_{Privacy}$	-116.468***	-12.660**	-182.504***	-14.988**	-25.368**	1.533
	(35.327)	(6.088)	(58.130)	(6.321)	(10.316)	(8.488)
$\#_{CleanPerm}$	0.266	0.849	0.344	1.011*	1.498**	-1.310
	(3.473)	(0.598)	(5.476)	(0.595)	(0.694)	(1.263)
Constant	264.070***	4.262	320.040***	2.428	10.214	6.258
	(29.120)	(5.018)	(48.089)	(5.229)	(9.514)	(6.209)
Observations	192	192	162	162	96	96
Mean of dep. Var.	175.94	-0.24	176.85	-3.22	-1.07	0.59
SD of dep. Var.	188.76	31.81	274.05	29.27	32.96	30.78
Adjusted R^2	0.056	0.013	0.059	0.025	0.062	-0.006

Notes: This table shows further demand side results from comparing the download ranks of an app in the iOS Appstore and Google's Play Store depending on whether it's Android version uses privacy-sensitive permissions or not. The dependent variable captures differences in the ranks on the two platforms (iOS App Store ranks minus Google Play Store ranks). Colums 1, 2, 5 and 6 compare the apps' average ranks of the seven countries we collected ranks for, whereas Columns 3 & 4 use only the US ranks. Columns 1 & 3 use as dependent variable the difference between the simple rank averages whereas Columns 2 & 4 use as the dependent variable the difference between the newly created ranks within the operating system, which are based on the average download ranks we observed on AppAnnie.com. Columns 5 & 6 also use the difference between the newly created ranks based on the average download ranks but contrast games (Column 6) with other apps (Column 5). Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

[5]Such apps are clearly overrepresented in the small sample of apps for which we were able to retrieve ranks in 2016.

2.4.4 Robustness of Demand-side Results to Using Alternative Demand Measures

It is crucial for the validity of our research to analyze whether our main findings for the demand-side depend on the definition of our demand-measure. To verify that this is not the case, we varied the dependent variable, and run our main specification with eight alternative demand measures and two alternative measures of app popularity. The results are shown in Table B12, where we show our main specification with alternative dependent variables based on actual installations, alternative measures based on ratings, and when using predicted installations that we calibrated using the available information on ratings and installations. Verifying our results for predicted installations highlights that our findings are in line with the previous literature that has used predicted installations.

Data Preparation and Additional Variables: We estimate our main specification with eight alternative demand measures based on ratings (cols. 1&2), the direct measure of installations (cols. 3-5), and three measures of predicted monthly new installations (cols. 6-8). In addition we provide results with respect to apps' average ratings (cols. 9&10). All specifications use the cross section data from April 2012. In the following we describe the various different demand measures we use in Table B12.

- In column 1 the dependent variable is ΔR_{AprSep} which equals the change in the number of ratings between April and September 2012.
- In column 2 the dependent variable is ΔR_{1214} which equals the change in the number of ratings between 2012 and 2014.
- In column 3 the dependent variable is ΔI_{Apr} which equals the change in the number of installations in April 2012.
- In column 4 the dependent variable is ΔI_{AprSep} which equals the change in the number of installations between April and September 2012.
- In column 5 the dependent variable is ΔI_{1214} which equals the change in the number of installations between 2012 and 2014.
- In column 6 the dependent variable equals the predicted change in the number of installations in April 2012. We predict this change based on a log-log-specified estimation specification where the dependent variable is the log. number of new installations and the explanatory variable is the log. number of new ratings an app has received in April 2012 (see Column 2 of Table A12).
- In column 7 the dependent variable equals the predicted change in the number of installations between April and September 2012. We predict this change based on a log-log estimation specification where the dependent variable is the log. number of new installations and the explanatory variable is the log. number of new ratings an app has received between April and September 2012 (see Column 4 of Table A12).
- In column 8 the dependent variable equals the predicted change in the number of installations in April 2012. We predict this change based on a non-parametric estimation specification

where the dependent variable is the log. number of new installations and the explanatory variable is the log. number of new ratings an app has received in April 2012 (see Column 8 of Table A12).

- In column 9 the dependent variable equals AR_{Apr} which is the average of the ratings the app has received in April 2012.
- In column 10 the dependent variable equals AR_{AprSep} which is the average of the ratings the app has received between April and September 2012.

Results: Our main demand-side results remain the same, independently of whether we use measures based on installations or measures based on ratings as well as whether we consider a longer time window of ratings- or installation growth (cols. 1-5). Similarly, when we use predicted changes in the number of installations (cols. 6-8), our results are also confirmed. Finally, the results in Columns 9 and 10 indicate that apps receive worse ratings if they use privacy-sensitive permissions and thus seem to be less popular among users.

Table B12: Alternative Demand Measures

	Ratings-Based		Installations-Based			Predicted New Installations			Average Rating	
	ΔR_{AprSep}	ΔR_{1214}	ΔI_{Apr}	ΔI_{AprSep}	ΔI_{1214}	param.	param. 1214	non-param.	AR_{Apr}	AR_{AprSep}
$D_{Privacy}$	-0.093***	-0.070***	-0.054***	-0.197***	-0.388***	-0.030***	-0.053***	-0.183***	-0.022***	-0.018***
	(0.011)	(0.015)	(0.016)	(0.025)	(0.036)	(0.004)	(0.007)	(0.024)	(0.003)	(0.003)
$\#_{CleanPerm}$	0.042***	0.035***	0.010***	0.014**	-0.010	0.017***	0.030***	0.069***	0.000	0.000
	(0.003)	(0.004)	(0.004)	(0.006)	(0.008)	(0.001)	(0.002)	(0.006)	(0.001)	(0.001)
$D_{Internet}$	-0.220***	-0.250***	-0.078***	-0.206***	-0.317***	-0.092***	-0.163***	-0.416***	-0.054***	-0.056***
	(0.012)	(0.016)	(0.015)	(0.025)	(0.037)	(0.004)	(0.007)	(0.026)	(0.004)	(0.004)
D_{Ads}	0.326***	0.356***	0.248***	0.618***	0.925***	0.109***	0.192***	0.613***	0.009**	0.014***
	(0.011)	(0.016)	(0.015)	(0.024)	(0.037)	(0.004)	(0.007)	(0.025)	(0.004)	(0.003)
Log. Price	-0.114***	-0.173***	-0.038***	-0.113***	-0.307***	-0.033***	-0.058***	-0.201***	-0.002***	-0.005***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)	(0.000)	(0.001)	(0.002)	(0.000)	(0.000)
D_{Other}	0.071***	0.058***	0.062***	0.165***	0.168***	0.024***	0.042***	0.155***	0.006*	-0.003
	(0.011)	(0.016)	(0.015)	(0.025)	(0.035)	(0.004)	(0.008)	(0.024)	(0.003)	(0.003)
Log. Length Desc.	0.373***	0.443***	0.157***	0.377***	0.564***	0.121***	0.214***	0.690***	0.006***	0.006***
	(0.005)	(0.007)	(0.007)	(0.011)	(0.016)	(0.002)	(0.003)	(0.011)	(0.002)	(0.001)
Log. Size (in KB)	0.092***	0.104***	0.029***	0.077***	0.160***	0.029***	0.051***	0.146***	0.009***	0.012***
	(0.003)	(0.004)	(0.004)	(0.006)	(0.009)	(0.001)	(0.002)	(0.006)	(0.001)	(0.001)
Number Screenshots	0.113***	0.142***	0.058***	0.142***	0.260***	0.039***	0.069***	0.204***	0.012***	0.013***
	(0.003)	(0.004)	(0.004)	(0.006)	(0.008)	(0.001)	(0.002)	(0.006)	(0.001)	(0.001)
Dummy: Video	0.212***	0.302***	0.019	0.007	0.131***	0.094***	0.166***	0.408***	0.014***	0.012***
	(0.014)	(0.020)	(0.022)	(0.033)	(0.047)	(0.006)	(0.010)	(0.030)	(0.004)	(0.003)
Log. Average Rating	0.272***	0.421***	0.168***	0.410***	0.886***	0.092***	0.162***	0.511***		
	(0.010)	(0.016)	(0.011)	(0.020)	(0.035)	(0.003)	(0.006)	(0.024)		
Dummy: Top-Dev.	1.263***	1.668***	0.124	-0.066	0.262	0.525***	0.929***	1.733***	0.007	-0.013
	(0.062)	(0.084)	(0.102)	(0.151)	(0.235)	(0.027)	(0.047)	(0.110)	(0.009)	(0.009)
App Version	0.045***	0.062***	-0.036***	-0.050***	-0.030*	0.013***	0.023***	0.075***	0.004**	0.004***
	(0.005)	(0.007)	(0.006)	(0.010)	(0.016)	(0.002)	(0.003)	(0.010)	(0.002)	(0.001)
Log. AppsByDev	-0.182***	-0.211***	-0.066***	-0.154***	-0.173***	-0.052***	-0.093***	-0.346***	-0.007***	-0.001
	(0.002)	(0.004)	(0.003)	(0.005)	(0.010)	(0.001)	(0.002)	(0.005)	(0.001)	(0.001)
Log. InstByDev	0.258***	0.311***	0.043***	0.111***	0.182***	0.085***	0.150***	0.476***	0.015***	0.015***
	(0.002)	(0.003)	(0.003)	(0.004)	(0.006)	(0.001)	(0.001)	(0.004)	(0.001)	(0.001)
Log. InstByComp	-0.025***	-0.041***	-0.007**	-0.046***	-0.073***	-0.003***	-0.006***	-0.059***	-0.007***	-0.005***
	(0.002)	(0.003)	(0.003)	(0.005)	(0.008)	(0.001)	(0.001)	(0.005)	(0.001)	(0.001)
Log. PriceOfComp	0.007***	0.003**	-0.006***	-0.012***	-0.020***	0.005***	0.009***	0.006***	-0.001***	-0.001***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)	(0.000)	(0.001)	(0.002)	(0.000)	(0.000)
Log. RatByComp	-1.118***	-1.451***	-0.106	-0.375**	-0.632**	-0.326***	-0.577***	-2.445***	0.449***	0.436***
	(0.076)	(0.108)	(0.103)	(0.172)	(0.258)	(0.028)	(0.050)	(0.169)	(0.024)	(0.020)
Min. Android Vers.	-0.022*	-0.022	0.294***	0.751***	1.316***	-0.007	-0.012	0.018	-0.000	0.004
	(0.013)	(0.019)	(0.018)	(0.030)	(0.043)	(0.005)	(0.009)	(0.029)	(0.005)	(0.004)
Max. Android Vers.	0.302***	0.636***	0.165***	0.508***	1.629***	0.078***	0.139***	0.529***	0.020**	0.006
	(0.026)	(0.039)	(0.029)	(0.048)	(0.080)	(0.009)	(0.016)	(0.057)	(0.010)	(0.008)
Constant	-4.583***	-5.540***	-3.557***	-6.936***	-13.206***	-2.248***	-3.083***	-6.608***	0.354***	0.360***
	(0.156)	(0.229)	(0.196)	(0.324)	(0.505)	(0.056)	(0.100)	(0.345)	(0.055)	(0.046)
Category	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	176212	124482	177193	177193	126987	177193	177193	177193	68248	102594
Mean of dep. Var.	0.97	2.40	-0.42	0.86	4.63	-0.42	0.16	2.76	1.29	1.29
SD of dep. Var.	2.03	2.52	2.34	3.89	5.16	0.72	1.27	4.25	0.35	0.35
Adjusted R^2	0.360	0.388	0.037	0.086	0.201	0.294	0.294	0.272	0.043	0.052

Notes: The table shows descriptive regressions analyzing the relationship between privacy-sensitive permissions and app demand by using various different demand and app popularity measures. Columns 1 and 2 use alternative demand measures based on ratings, Columns 3-5 use demand measures based on installations, whereas Columns 6-8 use three measures of predicted new installations which we estimated based on the information about the number of new ratings. Columns 9 and 10 use the average ratings of apps as a measure of app popularity. In Column 1 (2) the dependent variable is the log. number of new ratings between April and September 2012 (log. number of new ratings between 2012 and 2014). In Column 3 the dependent variable is the log. number of new installations in April 2012. Columns 4 and 5 use the log. number of new installations between April and September 2012 (Column 4) and between 2012 and 2014 (Column 5) as demand measures. In Columns 6-8 we apply three measures of predicted download numbers. For each of the measures we exploit the cross-section information on changes in ratings to predict changes in installation numbers. In Column 6, we use a measure of predicted monthly installation changes in April 2012 which is based on the observed change in the number of ratings in this month (see Column 2 of Table A12). In Column 7, we use a measure of predicted installation changes between April and September 2012 which is based on the observed change in the number of ratings in this period (see Column 4 of Table A12). In Column 8, we again use a measure of predicted monthly installation changes in April 2012 which is based on the observed change in the number of ratings in this month (see Column 2 of Table A12), but instead of employing a parametric log-log-specification to the data, we employ a non-parametric approach to it. In Columns 9 the dependent variable is the log. average of the ratings the app has received in April 2012, whereas in Column 10 it is the log. average of the ratings the app has received between April and September 2012. Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

2.4.5 Robustness of Demand-side results to Using Alternative Privacy Measures

We verified that our results do not depend on our definition of privacy-sensitive permissions. Clearly, such a dependency would cast doubt on the generalizeability of our findings. To test the robustness of our findings to using alternative implementations, we estimate our main specification with seven alternative privacy measures.

Data Preparation and Additional Variables: All specifications use the cross section data from April 2012. In the following we describe the various different privacy measures we use in Table B13.

1. We generated indicators for each number of permissions. This results in three dummies for 1, 2, and 3 or more permissions respectively (Column 1).

2. We asked 450 microworkers on Amazon's mechanical turk to classify permissions as to whether they thought they were neutral, problematic or very problematic. From these classifications we generated a dummy variable which is equal to one if an app uses at least one privacy-sensitive permission which was classified as problematic by the microworkers (Column 2).

3. We identified privacy-sensitive permissions that are unusual for the app's category. We flag a privacy-sensitive permission as category-specific problematic if paid apps of the category use this permission less frequently than the average paid app across all categories (Column 3).

4. We used additional data from *privacygrade.org* by Lin, Hong, and Sadeh. (2014), which evaluated apps' intrusiveness in 2014.[6] We created a dummy which equals 1 if an app got a rating that indicated the app was privacy-intrusive in 2014 (ratings equal to 'B', 'C' or 'D'). (Column 4).

5. We introduce and estimate a crossterm that indicates apps, which used both at least one privacy-sensitive permission and internet access. We use this specification to test if users distinguish sensitive permissions that come with internet access from sensitive permissions that come without the ability to transmit the sensitive data (Columns 5 & 6).

6. We disaggregated the privacy sensitive permissions into functionality related types of permissions, distinguishing location-, communication-, user ID-, or profile-specific permissions (Column 7).

7. We used an alternative definition of privacy-sensitive permissions from previous research by Sarma, Li, Gates, Potharaju, Nita-Rotaru, and Molloy (2012). This definition classified only 12 permissions as privacy-sensitive, and is thus more restrictive (Column 8).[7]

We then proceeded to run our main specification with these alternative measures/definitions of a "privacy-sensitive" app.

[6] To provide this measure a group of researchers evaluated all apps with respect to how they privacy-sensitive data Lin, Hong, and Sadeh. (2014).

[7] These permissions include: read phone state and ID, coarse location, fine gps location, intercept outgoing calls, read sms or mms, receive sms, receive mms, record audio, receive wap, read contact data, read browser data, read sensitive log data.

Results: The results are shown in Table B13. The dependent variable is demand for the app measured by log. number of monthly new ratings of an app. The coefficient of interest analyzes the relationship between an app's demand and our measures of privacy-sensitive permissions. Each column presents the results obtained when using an alternative measure for the presence of privacy-sensitive permissions. The results show that the weakly negative relationship between permissions and downloads holds across almost all definitions we consider. To be precise, the coefficient that measures the relationship between app-demand and the use privacy-sensitive permissions is negative for almost all definitions. The only exception is the *privacygrade* measure, which was published in 2014 on *privacygrade.org*. In contrast, the number of clean/unproblematic permissions is positively associated with demand in most specifications, which indicates that such permissions do not face lower demand.

Table B13: Alternative Privacy Measures

Log. $\Delta Ratings$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\#_{Privacy=1}$	-0.054***							
	(0.010)							
$\#_{Privacy=2}$	-0.087***							
	(0.014)							
$\#_{Privacy\geq 3}$	-0.089***							
	(0.014)							
$D_{Privacy}$		-0.060***	-0.048***	-0.040***		-0.086***		
		(0.009)	(0.010)	(0.014)		(0.018)		
$D_{MTurkEP2}$		-0.021*						
		(0.013)						
$D_{PrivCatSpec}$			-0.048***					
			(0.012)					
D_{PGrade}				0.148***				
				(0.020)				
$D_{Privacy} \times D_{Internet}$					-0.057***	0.025		
					(0.010)	(0.019)		
D_{ID}							0.046***	
							(0.009)	
$D_{Location}$							-0.200***	
							(0.014)	
$D_{Communication}$							-0.015	
							(0.016)	
$D_{Profile}$							-0.034***	
							(0.011)	
$D_{Sarmaetal}$								-0.048***
								(0.009)
$\#_{CleanPerm}$	0.038***	0.037***	0.037***	0.048***	0.036***	0.037***	0.038***	0.036***
	(0.003)	(0.003)	(0.003)	(0.005)	(0.003)	(0.003)	(0.003)	(0.003)
$D_{Internet}$	-0.202***	-0.201***	-0.199***	-0.288***	-0.192***	-0.204***	-0.201***	-0.202***
	(0.009)	(0.009)	(0.009)	(0.015)	(0.009)	(0.010)	(0.009)	(0.009)
D_{Ads}	0.234***	0.234***	0.235***	0.260***	0.236***	0.235***	0.219***	0.235***
	(0.009)	(0.009)	(0.009)	(0.014)	(0.009)	(0.009)	(0.009)	(0.009)
Log. Price	-0.071***	-0.071***	-0.071***	-0.094***	-0.071***	-0.071***	-0.072***	-0.071***
	(0.001)	(0.001)	(0.001)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)
D_{Other}	0.053***	0.052***	0.053***	0.017	0.048***	0.052***	0.048***	0.047***
	(0.009)	(0.009)	(0.009)	(0.014)	(0.009)	(0.009)	(0.009)	(0.009)
Log. Length Desc.	0.262***	0.263***	0.262***	0.287***	0.262***	0.263***	0.261***	0.262***
	(0.004)	(0.004)	(0.004)	(0.006)	(0.004)	(0.004)	(0.004)	(0.004)
Log. Size (in KB)	0.063***	0.063***	0.062***	0.087***	0.063***	0.062***	0.061***	0.062***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
Number Screenshots	0.085***	0.085***	0.085***	0.105***	0.085***	0.085***	0.086***	0.085***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
Dummy: Video	0.205***	0.205***	0.205***	0.256***	0.203***	0.204***	0.208***	0.203***
	(0.012)	(0.012)	(0.012)	(0.020)	(0.012)	(0.012)	(0.012)	(0.012)
Log. Average Rating	0.199***	0.198***	0.199***	0.456***	0.199***	0.198***	0.201***	0.199***
	(0.007)	(0.007)	(0.007)	(0.015)	(0.007)	(0.007)	(0.007)	(0.007)
Dummy: Top-Dev.	1.140***	1.139***	1.135***	1.121***	1.139***	1.139***	1.128***	1.138***
	(0.058)	(0.058)	(0.058)	(0.099)	(0.058)	(0.058)	(0.058)	(0.058)
App Version	0.029***	0.028***	0.028***	0.050***	0.028***	0.029***	0.027***	0.028***
	(0.004)	(0.004)	(0.004)	(0.006)	(0.004)	(0.004)	(0.004)	(0.004)
Log. AppsByDev	-0.113***	-0.114***	-0.113***	-0.145***	-0.114***	-0.114***	-0.113***	-0.114***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.002)	(0.002)	(0.002)	(0.002)
Log. InstByDev	0.183***	0.184***	0.184***	0.245***	0.184***	0.184***	0.182***	0.184***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
Log. InstByComp	-0.007***	-0.007***	-0.007***	-0.001	-0.007***	-0.007***	-0.007***	-0.007***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
Log. PriceOfComp	0.011***	0.011***	0.011***	0.016***	0.011***	0.011***	0.011***	0.011***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Log. RatByComp	-0.707***	-0.707***	-0.704***	-0.833***	-0.705***	-0.708***	-0.697***	-0.704***
	(0.061)	(0.061)	(0.061)	(0.097)	(0.061)	(0.061)	(0.061)	(0.061)
Min. Android Vers.	-0.014	-0.015	-0.015	-0.036**	-0.016	-0.014	-0.013	-0.015
	(0.010)	(0.010)	(0.010)	(0.016)	(0.010)	(0.010)	(0.010)	(0.010)
Max. Android Vers.	0.170***	0.170***	0.170***	-0.127*	0.171***	0.170***	0.174***	0.170***
	(0.020)	(0.020)	(0.020)	(0.071)	(0.020)	(0.020)	(0.020)	(0.020)
Constant	-3.878***	-3.872***	-3.880***	-3.785***	-3.878***	-3.867***	-3.914***	-3.870***
	(0.122)	(0.122)	(0.123)	(0.322)	(0.123)	(0.123)	(0.122)	(0.122)
Category	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	177193	177193	177193	86834	177193	177193	177193	177193
Mean of dep. Var.	0.10	0.10	0.10	0.51	0.10	0.10	0.10	0.10
SD of dep. Var.	1.55	1.55	1.55	1.71	1.55	1.55	1.55	1.55
Adjusted R^2	0.294	0.294	0.294	0.288	0.294	0.294	0.295	0.294

Notes: The table shows descriptive regressions analyzing the relationship between the presence of privacy sensitive permissions and app demand. The dependent variable is demand for the app measured by log. number of monthly new ratings of an app. The coefficient of interest analyzes the relationship between an app's demand and our privacy measures. Each column presents the results obtained when using an alternative privacy measure. Column 1 introduces an indicator for each number of permission (having 1, 2, and 3 or more permissions). Column 2 uses a dummy variable which is equal to one if an app uses at least one privacy-sensitive permission which was classified as very problematic by 450 microworkers we surveyed on Amazon's mechanical turk. In Column 3 we look at privacy sensitive permissions that are unusual for the app's category. Within a category we flag a privacy-sensitive permission as problematic only if paid apps of this category use this permission on average less often than the overall average paid app. Column 4 uses the 'privacygrade' by Lin, Hong, and Sadeh. (2014), that was made available on *privacygrade.org* in 2014. The dummy is equal to one if the the app got a rating equal to 'B', 'C' or 'D', i.e. a rating indicating the app being privacy-intrusive. In Columns 5 & 6 we introduce a crossterm that is equal to one if an app uses both at least one privacy-sensitive permission and has internet access. Column 7 disaggregates the privacy sensitive permissions into functionality-related types of permissions. Column 8 uses an alternative definition of privacy-sensitive permissions from previous research by Sarma, Li, Gates, Potharaju, Nita-Rotaru, and Molloy (2012), which defines only 12 permissions as privacy-sensitive. Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

2.4.6 Robustness of Demand-side Results to using Alternative Estimation Techniques

Demand side results are robust to accounting for censoring, selection, network effects, or endogeneity: In Table B14 we analyze the robustness of our main demand-side results to the use of alternative estimation strategies that account for several potential endogeneity concerns. Specifically we check the sensitivity of our results with respect to censoring in the dependent variable, survivor bias, network effects, and strategic behavior of the developers when choosing requested permissions and prices. All of these checks require different estimation strategies that are discussed in the following.

Data Preparation, Additional Variables, and Estimation: In all specifications, the dependent variable is our main measure of app demand, i.e. the log. number of monthly new ratings, and the main variable of interest is a dummy that indicates the presence of privacy-sensitive permissions. All columns are based on the cross section from April 2012.

Columns 1 & 2 show Tobit-regressions that account for the fact that the dependent variable might be censored, especially might be left-censored at demand equal to zero. Column 1 sets the left-censoring limit to zero new ratings, whereas in Column 2 in addition a right-censoring limit equal to five is added.

Columns 3 & 4 contain results from Heckman selection models which aim to control for survivor bias, i.e. for the fact that apps using privacy-sensitive permissions might have lower demand and because of that might also have lower survival rates which would result in biased OLS estimates (underestimating the true effect of permissions) if these are based on a sample of surviving apps (as it is the case in our baseline demand estimates). In both heckman selection specifications (cols. 3 & 4) the regression equation is identical to our baseline cross-section demand specification and the selection equation models app survival. In column 3 survival is modeled by comparing apps which are observed throughout the period April to September 2012 to those which are observed in April, May and June, but which are not observed in the last two monthly waves (which we consider as an indication of their drop out). In column 4, survival is modeled by comparing apps within our baseline cross-section from April 2012 which survive until 2014 to those which are observed in April 2012 but are not observed in 2014. In both selection models we apply Heckman's (1979) two-step consistent estimator and use the information on code size as a selection variable, i.e. we include the code size only in the selection equation but not in the regression equation. In Table B14 we show only the results for the regression equation and not those for the selection equation but show both results together in Table B15. In addition, in Table B15 we also provide a detailed comparison of the reference OLS estimates for both specifications. Columns 2 &4 in this table shows the full Heckman (1979) specification, and tables 1&3 show the OLS regression that mirrors the second step of the Heckman's procedure.

In Column 5 we control for the existing user-base, which could affect demand through the existence of network effects, by including a control for the stock of existing installations (i.e. the log. number of installations).

In the following columns we estimate 2SLS models to instrument the variables of interest and to account for the endogeneity of the developers' privacy model choices. In Column 6 we instrument the privacy-dummy by the share of competing apps which use privacy-sensitve permissions

($ShareComp_{Privacy}$). Competing apps are those which are identified by Google as those which "users who viewed this [app] also viewed". In Column 7 we instrument the privacy-dummy by the share of the developer's other apps which use privacy-sensitive permissions (excluding the focal app) ($ShareDev_{Privacy}$). In Columns 8 and 9 we instrument the app price by using in both specifications two potential cost shifters: the log. code size and the log. number of apps a developer offers in the Google Play Store. In Column 8 we use the full cross-section, whereas in Column 9 we use only the sample of paid apps. Again, in Table B14 we only show the main results of these specifications, i.e. the second stage results, but provide for all four 2SLS specifications in Table B16 also the related first stage results.

Results: The results of all specifications support our baseline findings. The results in the first four columns suggest that neither accounting for censoring in the dependent variable (Col. 1-2), nor accounting for survivor bias (Col. 3-4) result in drastic changes of our main estimates. If anything, these specifications suggest a higher effect size, that is, these results suggest that privacy-sensitive permissions come with a stronger demand reduction than the baseline specifications. The Heckman selection models indeed support the idea that privacy-sensitive permissions come with a lower survival rate and thus with a bias of the OLS estimates towards zero (an underestimation of the true effect). Similar, controlling for past success and potential network effects (Col. 5) does not change our baseline conclusions drastically. The IV-estimations in Columns 6-9 show that our attempts to account for endogeneity in prices and permissions result in larger coefficient estimates, as would be expected if developers of better apps were to charge higher prices or ask for more permissions. In all four IV-specifications, in the first stage, our IV variables are highly significant and can thus be considered relevant variables.

2.4.7 Robustness of Results to Splitting the Sample

In this robustness check we verify that the negative relationship between demand and privacy-sensitive permissions is not driven by a specific type of app. We do so by splitting the sample into groups of apps where privacy could matter differently. This rules out an important alternative explanation, and highlights that the phenomenon we highlight affects the entire market.

Data Preparation and Additional Variables: To analyze the robustness of the demand-side results across different subsamples, we split our cross section data from April 2012 into groups of apps where the role of privacy could be of varying importance and estimate the main specification from Table B7 for each group separately. We divide the data along four dimensions: (i) pricing strategy (Col. 1-2), (ii) Game or normal app (Col. 3-4), (iii) user groups by maturity requirements (Col. 5-6), and (iv) by the presence or absence of health-relevant content (Col. 7-8). More precisely, in column 1 we consider free apps whereas in column 2 we consider paid apps. In column 3 we analyze non-game apps whereas in column 4 we consider games. In column 5 we restrict the sample to apps which are for users of higher maturity (age), whereas column 6 is based on apps for users recommended for 'everyone' or for 'low maturity'-users. Finally, in column 7 we consider apps from the categories 'health'- and 'medical'-apps whereas in column 8 we use the remaining apps.

Table B14: Alternative Estimation Specifications

	Tobit		Heckman		Netw.Eff.	IV-Privacy		IV-Price	
Log. $\Delta Ratings$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$D_{Privacy}$	-0.094***	-0.095***	-0.063***	-0.164***	-0.069***	-0.918***	-0.372***	-0.091***	-0.063***
	(0.017)	(0.017)	(0.009)	(0.024)	(0.007)	(0.049)	(0.017)	(0.009)	(0.017)
Log. Installations					0.417***				
					(0.002)				
$\#_{CleanPerm}$	0.055***	0.057***	0.038***	0.019***	0.026***	0.065***	0.044***	0.043***	0.082***
	(0.004)	(0.004)	(0.002)	(0.005)	(0.002)	(0.004)	(0.003)	(0.003)	(0.007)
$D_{Internet}$	-0.325***	-0.333***	-0.184***	-0.423***	-0.168***	-0.099***	-0.177***	-0.289***	-0.005
	(0.020)	(0.021)	(0.010)	(0.030)	(0.007)	(0.012)	(0.011)	(0.014)	(0.017)
D_{Ads}	0.436***	0.443***	0.234***	0.291***	0.203***	0.243***	0.253***	0.198***	0.043**
	(0.018)	(0.018)	(0.010)	(0.023)	(0.007)	(0.011)	(0.011)	(0.011)	(0.020)
Log. Price	-0.172***	-0.174***	-0.068***	-0.157***	0.040***	-0.074***	-0.074***	-0.108***	-0.687***
	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.004)	(0.094)
D_{Other}	0.098***	0.098***	0.063***	0.058***	0.046***	0.182***	0.115***	0.079***	0.117***
	(0.017)	(0.017)	(0.009)	(0.020)	(0.007)	(0.014)	(0.011)	(0.010)	(0.020)
Log. Length Desc.	0.521***	0.529***	0.272***	0.503***	0.094***	0.290***	0.253***	0.298***	0.219***
	(0.008)	(0.008)	(0.004)	(0.010)	(0.003)	(0.005)	(0.004)	(0.005)	(0.012)
Log. Size (in KB)	0.120***	0.122***			0.044***	0.069***	0.064***		
	(0.005)	(0.005)			(0.002)	(0.003)	(0.002)		
Number Screenshots	0.152***	0.155***	0.095***	0.183***	0.068***	0.077***	0.075***	0.106***	0.070***
	(0.004)	(0.004)	(0.002)	(0.005)	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)
Dummy: Video	0.291***	0.299***	0.230***	0.361***	0.108***	0.235***	0.211***	0.221***	0.283***
	(0.021)	(0.021)	(0.011)	(0.027)	(0.010)	(0.014)	(0.013)	(0.012)	(0.020)
Log. Average Rating	0.656***	0.667***	0.215***	0.444***	0.289***	0.188***	0.204***	0.211***	0.079***
	(0.023)	(0.023)	(0.010)	(0.024)	(0.007)	(0.009)	(0.008)	(0.008)	(0.009)
Dummy: Top-Dev.	1.186***	1.291***	1.192***	1.544***	0.499***	1.201***	1.038***	1.242***	1.490***
	(0.075)	(0.082)	(0.044)	(0.108)	(0.043)	(0.064)	(0.058)	(0.060)	(0.094)
App Version	0.069***	0.070***	0.027***	0.038***	-0.026***	0.038***	0.023***	-0.004	0.016**
	(0.008)	(0.008)	(0.004)	(0.009)	(0.003)	(0.004)	(0.004)	(0.004)	(0.007)
Log. AppsByDev	-0.332***	-0.337***	-0.115***	-0.459***	-0.025***	-0.099***	-0.093***		
	(0.005)	(0.005)	(0.003)	(0.025)	(0.002)	(0.002)	(0.002)		
Log. InstByDev	0.406***	0.413***	0.181***	0.317***	0.029***	0.190***	0.206***	0.178***	0.105***
	(0.004)	(0.004)	(0.002)	(0.004)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Log. InstByComp	-0.050***	-0.051***	-0.008***	-0.055***	0.015***	-0.000	-0.003	-0.012***	-0.019***
	(0.004)	(0.004)	(0.002)	(0.005)	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)
Log. PriceOfComp	0.008***	0.009***	0.011***	0.007***	0.010***	0.011***	0.015***	0.018***	0.012***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Log. RatByComp	-2.002***	-2.017***	-0.743***	-1.684***	0.560***	-0.799***	-0.613***	-0.750***	-0.380***
	(0.122)	(0.124)	(0.063)	(0.151)	(0.050)	(0.063)	(0.067)	(0.063)	(0.111)
Min. Android Vers.	0.047**	0.045**	0.007	-0.145***	0.313***	-0.022*	0.014	0.039***	0.067***
	(0.022)	(0.022)	(0.010)	(0.030)	(0.009)	(0.012)	(0.012)	(0.011)	(0.018)
Max. Android Vers.	0.409***	0.416***	0.175***	0.830***	0.158***	0.187***	0.182***	0.152***	0.177***
	(0.046)	(0.047)	(0.022)	(0.056)	(0.016)	(0.024)	(0.024)	(0.020)	(0.034)
Constant	-8.802***	-8.975***	-3.533***	-5.781***	-6.472***	-4.141***	-4.305***	-3.970***	-3.300***
	(0.266)	(0.271)	(0.127)	(0.319)	(0.100)	(0.136)	(0.141)	(0.128)	(0.197)
Category	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes
Observations	177193	177193	185533	177193	177193	136040	137146	177193	48272
Mean of dep. Var.	0.10	0.10	0.10	2.40	0.10	0.10	0.10	0.10	-0.50
SD of dep. Var.	1.55	1.55	1.55	2.52	1.55	1.55	1.56	1.55	1.06
Adjusted R^2					0.534	0.256	0.324	0.269	0.047

Notes: The table analyzes the robustness of our main demand-side results to using alternative estimation strategies. The dependent variable is app demand measured by the log. number of monthly new ratings, and the main variable of interest is a dummy that indicates the presence of privacy-sensitive permissions. All columns show cross section results. Columns 1 & 2 show Tobit-regressions that account for the fact that the dependent variable might be censored, especially might be left-censored at demand equal to 0. Column 1 sets the left-censoring limit to 0 new ratings, whereas in Column 2 in addition a right-censoring limit equal to 5 is set. Columns 3 & 4 contain results from Heckman selection models, where the regression equation is identical to our baseline cross-section demand specification, i.e. the dependent variable is the log. number of monthly or biannual new ratings, and the selection equation models app survival. In column 3 survival is modeled by comparing apps which are observed throughout the period April to September 2012 to those which are observed in April 2012 but which cannot be observed in later months. In column 4 survival is modeled by comparing apps within our baseline cross-section from April 2012 which survive until 2014 to those which are observed in April 2012 but are not observed in 2014. In both selection models we apply Heckman's two-step consistent estimator and use the information on code size as the selection variable, i.e. we include the code size only in the selection equation but not in the regression equation. In Column 5 we control for the existing user-base by including a control for the stock of existing installations (log. number of installations). In Columns 6 and 7 we estimate a 2SLS model and instrument the variable of interest to account for the endogeneity of the developers' privacy model choice. In Column 6 we instrument the privacy-dummy by the share of competing apps which use privacy-sensitve permissions ($ShareComp_{Privacy}$). In Column 7 we instrument the privacy-dummy by the share of the apps of the developer which use privacy-sensitive permissions ($ShareDev_{Privacy}$). In Columns 8 and 9 we instrument the app price by using in both specifications two potential cost shifters: the log. code size and the log. number of apps a developer offers in the Google Play Store. In Column 8 we use the full cross-section, whereas in Column 9 we use only the sample of paid apps. Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table B15: Baseline OLS and Full Heckman Selection Models

	Heckman (1)		Heckman (2)	
	OLS	Heckman	OLS	Heckman
main				
$D_{Privacy}$	-0.055***	-0.063***	-0.048***	-0.164***
	(0.009)	(0.009)	(0.016)	(0.024)
$\#_{CleanPerm}$	0.041***	0.038***	0.043***	0.019***
	(0.003)	(0.002)	(0.005)	(0.005)
$D_{Internet}$	-0.187***	-0.184***	-0.228***	-0.423***
	(0.009)	(0.010)	(0.016)	(0.030)
D_{Ads}	0.243***	0.234***	0.366***	0.291***
	(0.009)	(0.010)	(0.016)	(0.023)
Log. Price	-0.069***	-0.068***	-0.169***	-0.157***
	(0.001)	(0.001)	(0.001)	(0.002)
Log. AppsByDev	-0.112***	-0.115***	-0.207***	-0.459***
	(0.002)	(0.003)	(0.004)	(0.025)
Constant	-3.520***	-3.533***	-4.958***	-5.781***
	(0.122)	(0.127)	(0.229)	(0.319)
select				
$D_{Privacy}$		-0.099***		-0.081***
		(0.014)		(0.009)
$\#_{CleanPerm}$		-0.026***		-0.013***
		(0.002)		(0.002)
$D_{Internet}$		0.026		-0.158***
		(0.018)		(0.010)
D_{Ads}		-0.131***		-0.054***
		(0.015)		(0.009)
Log. Price		0.003**		0.008***
		(0.001)		(0.001)
Log. AppsByDev		-0.042***		-0.165***
		(0.003)		(0.002)
Log. Size (in KB)		-0.019***		-0.012***
		(0.004)		(0.002)
Constant		2.383***		1.066***
		(0.208)		(0.129)
mills				
lambda		0.486**		2.978***
		(0.194)		(0.281)
Category	Yes	No	Yes	No
Controls	Yes	Yes	Yes	Yes
Observations	177193	185533	124482	177193
Mean of dep. Var.	0.10	0.10	2.40	2.40
SD of dep. Var.	1.55	1.55	2.52	2.52
Adjusted R^2	0.291		0.384	

Notes: The table analyzes the robustness of our main demand-side results to using alternative estimation strategies. The dependent variable is app demand measured by the log. number of monthly new ratings, and the main variable of interest is a dummy that indicates the presence of privacy-sensitive permissions. All columns show cross section results. Column 1 shows OLS estimates for April 2012 (like in our baseline demand equation but without the code size variable). Column 2 & 4 contain results from Heckman selection models, where the regression equation is identical to our baseline cross-section demand specification, i.e. the dependent variable is the log. number of monthly or biannual new ratings, and the selection equation models app survival. In column 2 survival is modeled by comparing apps which are observed throughout the period April to September 2012 to those which are observed in April 2012 but which cannot be observed in later months. Column 3 contains OLS estimates for those apps which are available both in 2012 and 2014. The dependent variable as in column 4 is the log. change in the number of ratings between 2012 and 2014. In column 4 survival is modeled by comparing apps within our baseline cross-section from April 2012 which survive until 2014 to those which are observed in April 2012 but are not observed in 2014. In both selection models we apply Heckman's two-step consistent estimator and use the information on code size as the selection variable, i.e. we include the code size only in the selection equation but not in the regression equation. Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Table B16: IV-Specifications (1st and 2nd Stage)

	IV-Privacy (1)		IV-Privacy (2)		IV-Price (1)		IV-Price (2)	
	2nd	1st	2nd	1st	2nd	1st	2nd	1st
$D_{Privacy}$	-0.918***		-0.372***		-0.091***	-0.337***	-0.063***	0.072***
	(0.049)		(0.017)		(0.009)	(0.029)	(0.017)	(0.009)
$\#_{CleanPerm}$	0.065***	0.027***	0.044***	0.016***	0.043***	0.069***	0.082***	0.032***
	(0.004)	(0.002)	(0.003)	(0.001)	(0.003)	(0.007)	(0.007)	(0.003)
$D_{Internet}$	-0.099***	0.108***	-0.177***	0.086***	-0.289***	-2.483***	-0.005	0.085***
	(0.012)	(0.003)	(0.011)	(0.003)	(0.014)	(0.035)	(0.017)	(0.009)
D_{Ads}	0.243***	0.032***	0.253***	0.014***	0.198***	-1.442***	0.043**	0.000
	(0.011)	(0.004)	(0.011)	(0.003)	(0.011)	(0.029)	(0.020)	(0.011)
Log. Price	-0.074***	-0.003***	-0.074***	-0.001***	-0.108***		-0.687***	
	(0.001)	(0.000)	(0.001)	(0.000)	(0.004)		(0.094)	
$ShareComp_{Privacy}$		0.279***						
		(0.004)						
$ShareDev_{Privacy}$				0.594***				
				(0.003)				
Log. Size (in KB)	0.069***	0.011***	0.064***	0.002***		0.381***		0.022***
	(0.003)	(0.001)	(0.002)	(0.001)		(0.008)		(0.002)
Log. AppsByDev	-0.099***	0.017***	-0.093***	0.005***		0.255***		0.022***
	(0.002)	(0.001)	(0.002)	(0.000)		(0.007)		(0.002)
D_{Other}	0.182***	0.144***	0.115***	0.090***	0.079***	0.170***	0.117***	0.122***
	(0.014)	(0.004)	(0.011)	(0.003)	(0.010)	(0.029)	(0.020)	(0.009)
Log. Length Desc.	0.290***	0.016***	0.253***	0.015***	0.298***	0.688***	0.219***	0.104***
	(0.005)	(0.001)	(0.004)	(0.001)	(0.005)	(0.012)	(0.012)	(0.004)
Number Screenshots	0.077***	-0.003***	0.075***	-0.001	0.106***	0.146***	0.070***	0.009***
	(0.003)	(0.001)	(0.002)	(0.001)	(0.002)	(0.007)	(0.003)	(0.002)
Dummy: Video	0.235***	0.041***	0.211***	0.017***	0.221***	-0.002	0.283***	0.045***
	(0.014)	(0.003)	(0.013)	(0.003)	(0.012)	(0.040)	(0.020)	(0.010)
Log. Average Rating	0.188***	-0.011***	0.204***	-0.014***	0.211***	-0.477***	0.079***	-0.015**
	(0.009)	(0.003)	(0.008)	(0.002)	(0.008)	(0.034)	(0.009)	(0.008)
Dummy: Top-Dev.	1.201***	0.064***	1.038***	0.032***	1.242***	2.787***	1.490***	0.425***
	(0.064)	(0.014)	(0.058)	(0.010)	(0.060)	(0.169)	(0.094)	(0.045)
App Version	0.038***	0.008***	0.023***	0.005***	-0.004	-0.618***	0.016**	-0.022***
	(0.004)	(0.001)	(0.004)	(0.001)	(0.004)	(0.014)	(0.007)	(0.004)
Log. InstByDev	0.190***	0.008***	0.206***	-0.001***	0.178***	-0.219***	0.105***	0.003**
	(0.002)	(0.000)	(0.002)	(0.000)	(0.002)	(0.005)	(0.002)	(0.001)
Log. InstByComp	-0.000	-0.001***	-0.003	0.003***	-0.012***	-0.220***	-0.019***	-0.017***
	(0.002)	(0.001)	(0.002)	(0.000)	(0.002)	(0.007)	(0.003)	(0.002)
Log. PriceOfComp	0.011***	0.001***	0.015***	0.001***	0.018***	0.204***	0.012***	0.010***
	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.002)	(0.002)	(0.001)
Log. RatByComp	-0.799***	-0.044***	-0.613***	-0.061***	-0.750***	1.918***	-0.380***	-0.692***
	(0.063)	(0.016)	(0.067)	(0.015)	(0.063)	(0.204)	(0.111)	(0.056)
Min. Android Vers.	-0.022*	-0.015***	0.014	-0.005**	0.039***	-0.601***	0.067***	-0.100***
	(0.012)	(0.003)	(0.012)	(0.003)	(0.011)	(0.035)	(0.018)	(0.010)
Max. Android Vers.	0.187***	-0.023***	0.182***	-0.008	0.152***	0.328***	0.177***	0.062***
	(0.024)	(0.007)	(0.024)	(0.007)	(0.020)	(0.069)	(0.034)	(0.020)
Constant	-4.141***	-0.195***	-4.305***	-0.069*	-3.970***	-10.267***	-3.300***	0.087
	(0.136)	(0.038)	(0.141)	(0.035)	(0.128)	(0.415)	(0.197)	(0.117)
Category	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	136040	136040	137146	137146	177193	177193	48272	48272
Mean of dep. Var.	0.10	0.44	0.10	0.43	0.10	-8.30	-0.50	0.26
SD of dep. Var.	1.55	0.50	1.56	0.50	1.55	5.26	1.06	0.73
Adjusted R^2	0.256	0.475	0.324	0.635	0.269	0.320	0.047	0.277

Notes: The dependent variable is app demand measured by the log. number of monthly new ratings, and the main variable of interest is a dummy that indicates the presence of privacy-sensitive permissions. All columns show cross section 2SLS results (as in Table A10). Columns 1, 3, 5, and 6 contain 2nd-stage results, whereas columns 2, 4, 6, and 8 contain 1st-stage results. In Columns 1 to 4 we instrument the privacy-dummy to account for the endogeneity of the developers' privacy model choice. In Columns 1 and 2 we instrument the privacy-dummy by the share of competing apps which use privacy-sensitve permissions ($ShareComp_{Privacy}$). In Columns 3 and 4 we instrument the privacy-dummy by the share of the apps of the developer which use privacy-sensitive permissions ($ShareDev_{Privacy}$). In Columns 5 to 8 we instrumtent the app price by using in both specifications two potential cost shifters: the log. code size and the log. number of apps a developer offers in the Google Play Store. In Columns 5 and 6 we use the full cross-section, whereas in Columns 7 and 8 we use only the sample of paid apps. Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

Results: Table B17 shows the results. In all specifications, the dependent variable is app demand and the variable of interest is an indicator for presence of privacy sensitive permissions ($D_{Privacy}$). App demand is measured by the log. number of monthly new ratings of an app. Column 1 shows the results for free apps only, and column 2 for paid apps only. The estimated coefficient is much more negative in paid apps. Columns 3 and 4 contrast non-game apps (col.3) with games (col. 4), and shows that the association between permissions and usage is negative only for non-games. Column 5 considers only apps for mature users, and column 6 all others. The estimations suggest that privacy-sensitive permissions matter more in apps for mature users. Column 7 focuses on non-health apps and column 8 on health related apps. All specifications control for the app's observed characteristics on the Play Store (the app's price, description, ratings, categorical dummies, etc.), and also control for internet access, and ad-specific permissions. Moreover, all specifications control for the number of unproblematic permissions ($CleanPerm$. The results show that our main demand-side result, the negative relationship between demand and permissions, can be found for almost all types of apps, except for games. The varying size of the coefficients indicates that the app's type matters for the strength of the relationship between demand and permissions. Users of free apps and games seem more willing to share data, and apps for mature users or health-related apps are less demanded when using privacy-sensitive permissions.

Table B17: Alternative Estimation Samples

	Free vs. Paid		Non-Games vs. Games		High vs. Low Maturity		Med.&Health vs. Oth.	
Log. $\Delta Ratings$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$D_{Privacy}$	-0.026**	-0.121***	-0.082***	-0.020	-0.109***	-0.054***	-0.151***	-0.060***
	(0.011)	(0.014)	(0.010)	(0.022)	(0.019)	(0.010)	(0.043)	(0.009)
$\#_{CleanPerm}$	0.037***	0.054***	0.037***	0.098***	0.028***	0.038***	0.029**	0.036***
	(0.003)	(0.006)	(0.003)	(0.009)	(0.008)	(0.003)	(0.014)	(0.003)
$D_{Internet}$	-0.256***	-0.075***	-0.211***	-0.201***	-0.108***	-0.211***	-0.106**	-0.203***
	(0.012)	(0.013)	(0.010)	(0.024)	(0.019)	(0.010)	(0.041)	(0.009)
D_{Ads}	0.241***	0.039**	0.228***	0.157***	0.292***	0.222***	0.180***	0.238***
	(0.010)	(0.017)	(0.010)	(0.024)	(0.025)	(0.010)	(0.042)	(0.009)
Log. Price	0.000	0.099***	-0.068***	-0.095***	-0.050***	-0.076***	-0.056***	-0.072***
	(.)	(0.007)	(0.001)	(0.002)	(0.002)	(0.001)	(0.003)	(0.001)
D_{Other}	0.016	0.022	0.023**	0.144***	0.116***	0.040***	0.057	0.053***
	(0.011)	(0.015)	(0.010)	(0.027)	(0.025)	(0.010)	(0.044)	(0.009)
Log. Length Desc.	0.280***	0.135***	0.255***	0.291***	0.237***	0.268***	0.257***	0.262***
	(0.005)	(0.006)	(0.004)	(0.011)	(0.011)	(0.004)	(0.018)	(0.004)
Log. Size (in KB)	0.080***	0.011***	0.050***	0.117***	0.044***	0.065***	0.064***	0.062***
	(0.003)	(0.003)	(0.002)	(0.006)	(0.005)	(0.002)	(0.010)	(0.002)
Number Screenshots	0.105***	0.057***	0.086***	0.085***	0.086***	0.084***	0.075***	0.085***
	(0.003)	(0.003)	(0.002)	(0.006)	(0.007)	(0.002)	(0.010)	(0.002)
Dummy: Video	0.271***	0.225***	0.204***	0.177***	0.072*	0.218***	0.024	0.208***
	(0.016)	(0.018)	(0.015)	(0.024)	(0.039)	(0.013)	(0.068)	(0.012)
Log. Average Rating	0.371***	0.083***	0.167***	0.355***	0.207***	0.204***	0.257***	0.196***
	(0.010)	(0.007)	(0.008)	(0.020)	(0.014)	(0.008)	(0.029)	(0.007)
Dummy: Top-Dev.	1.151***	1.169***	1.026***	1.295***	1.505***	1.104***	0.155	1.272***
	(0.088)	(0.082)	(0.074)	(0.092)	(0.212)	(0.060)	(0.126)	(0.063)
App Version	0.039***	0.036***	0.029***	0.017*	0.018*	0.032***	0.069***	0.027***
	(0.005)	(0.006)	(0.004)	(0.009)	(0.010)	(0.004)	(0.020)	(0.004)
Log. AppsByDev	-0.169***	-0.047***	-0.105***	-0.180***	-0.077***	-0.122***	-0.100***	-0.114***
	(0.003)	(0.002)	(0.002)	(0.005)	(0.004)	(0.002)	(0.010)	(0.002)
Log. InstByDev	0.236***	0.100***	0.179***	0.203***	0.140***	0.192***	0.164***	0.184***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.002)	(0.008)	(0.002)
Log. InstByComp	-0.010***	-0.007***	-0.007***	0.003	-0.007*	-0.007***	0.009	-0.007***
	(0.002)	(0.002)	(0.002)	(0.006)	(0.004)	(0.002)	(0.011)	(0.002)
Log. PriceOfComp	0.012***	0.004***	0.008***	0.019***	0.007***	0.011***	0.013***	0.011***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.004)	(0.001)
Log. RatByComp	-0.823***	0.148*	-0.696***	-1.085***	-0.424***	-0.761***	-0.765**	-0.716***
	(0.078)	(0.078)	(0.067)	(0.147)	(0.134)	(0.068)	(0.304)	(0.062)
Min. Android Vers.	-0.029**	0.125***	-0.025**	0.039	-0.022	-0.011	-0.076	-0.014
	(0.013)	(0.015)	(0.011)	(0.028)	(0.026)	(0.011)	(0.051)	(0.011)
Max. Android Vers.	0.171***	0.140***	0.155***	0.250***	0.187***	0.171***	0.146	0.171***
	(0.024)	(0.030)	(0.021)	(0.053)	(0.032)	(0.023)	(0.127)	(0.020)
Constant	-3.557***	-3.416***	-3.398***	-5.120***	-3.467***	-3.980***	-3.811***	-3.865***
	(0.152)	(0.172)	(0.140)	(0.306)	(0.247)	(0.140)	(0.669)	(0.125)
Category	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	128921	48272	147143	30050	27843	149350	6218	170975
Mean of dep. Var.	0.33	-0.50	0.07	0.26	-0.18	0.15	-0.08	0.11
SD of dep. Var.	1.65	1.06	1.52	1.70	1.38	1.58	1.38	1.56
Adjusted R^2	0.285	0.262	0.280	0.370	0.305	0.291	0.270	0.295

Notes: The table shows the relationship between the presence of privacy-sensitive permissions and app demand for subsamples of our data. App demand is measured by the log. number of monthly new ratings of an app. Columns 1 and 2 split the sample into apps which are for free or for paid. Columns 3 and 4 split the sample into normal apps and games. Columns 5 and 6 split them into apps which require a high (Column 5) or low (Column 6) maturity of the user (apps are defined as appropriate for low maturity if they classified as being recommended for 'everyone' or for 'low maturity'-users). Columns 7 and 8 split the sample into medical and health-related apps as well as into other apps. All specifications control for the number of unproblematic permissions ($\#CleanPerm.$). Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

2.4.8 Excluding the Most and Least Successfull Apps from Estimation

In Table B18 we further analyze the robustness of the main demand-side results to excluding the most or least successful apps from the analysis. This robustness check guarantees, that our results are not driven by the apps in the tails of the distribution in our dependent variable.

Data Preparation and Additional Variables: For this robustness check, we excluded the most and least successful apps. First we excluded the most succesful apps, i.e. the upper 5 percentiles with respect to the number of new ratings in April 2012 in Columns 1 and 2. Analogously, we exclude the least successful apps, without any new ratings in April 2012 (the least successful ones) in Columns 3 and 4. In Columns 5 and 6 we exclude both groups. Moreover we generated a dummy which equals 1 for apps which had accumulated more than 10000 installations (Col. 2, 4 & 6). As before app demand is measured by the log. number of monthly new ratings of an app. All specification use the cross section from April 2012.

Results: The results in columns 1, 3, and 5 of Table B18 are shown without accounting for apps with a very high stock of installations. In Columns 2, 4 and 6 we account for such highly successful apps, by adding a dummy which equals one if the app had accumulated a stock of at least 10000 installations in the past, and also add an interaction of this dummy with the privacy-dummy. All specifications control for the number of unproblematic permissions ($CleanPerm.$), and for the app's observed characteristics on the Play Store (the app's price, description, ratings, categorical dummies, etc.). We also control for internet access, and ad-specific permissions. The coefficient of interest analyzes the relationship between an app's downloads and our measures of privacy sensitive permissions. While the coefficient is negative for all specifications, it becomes smaller and statistically insignificant when excluding only the least successful ones (column 3). Thus, the table highlights that the negative relationship between privacy-sensitive permission and demand holds across a wide range of apps and does not depend on the inclusion of the distribution tails. In addition, it indicates that the stock of installations affects the sensitivity of users with respect to the existence of privacy-sensitive permissions.

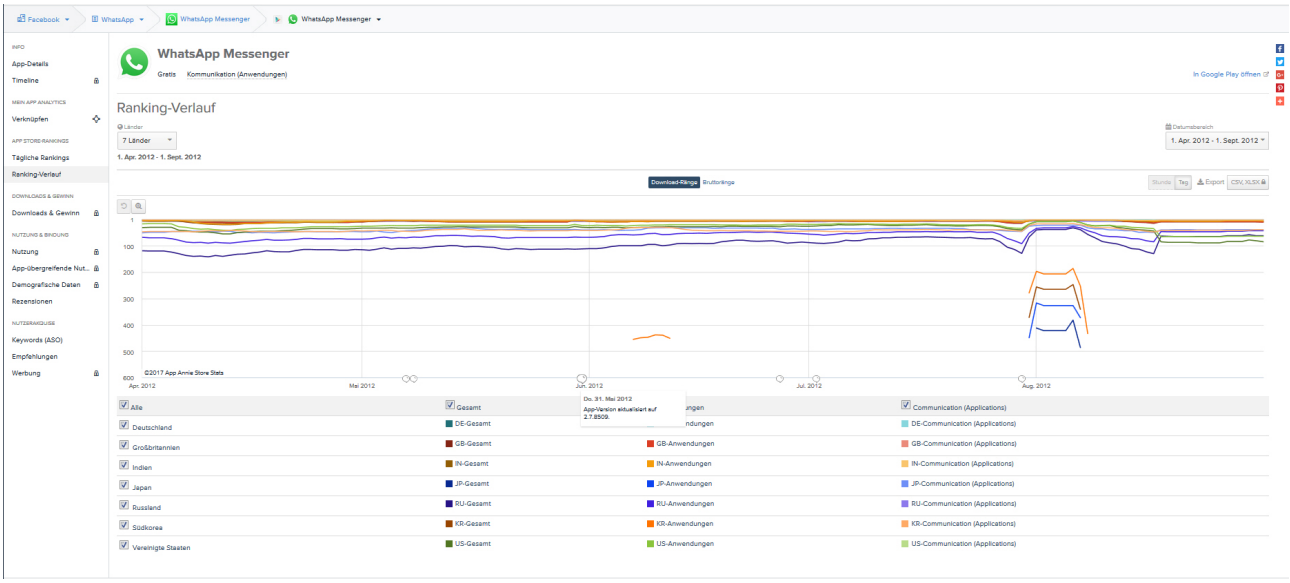
Table B18: Excluding the Most and Least Successful Apps

	W/o Top-Apps		W/o Flop-Apps		W/o Top- and Flop-Apps	
Log. $\Delta Ratings$	(1)	(2)	(3)	(4)	(5)	(6)
$D_{Privacy}$	-0.064***	-0.079***	-0.011	-0.086***	-0.030***	-0.050***
	(0.008)	(0.007)	(0.012)	(0.011)	(0.010)	(0.010)
$D_{NumInst}$		1.545***		1.303***		0.946***
		(0.011)		(0.012)		(0.011)
$D_{Privacy} \times D_{NumInst}$		0.036**		0.126***		0.009
		(0.015)		(0.017)		(0.014)
$\#_{CleanPerm}$	0.019***	0.019***	0.036***	0.032***	0.017***	0.018***
	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)
$D_{Internet}$	-0.114***	-0.093***	-0.197***	-0.172***	-0.092***	-0.090***
	(0.008)	(0.007)	(0.014)	(0.012)	(0.011)	(0.010)
D_{Ads}	0.170***	0.154***	0.182***	0.188***	0.102***	0.116***
	(0.008)	(0.007)	(0.012)	(0.011)	(0.010)	(0.009)
Log. Price	-0.055***	-0.026***	-0.071***	-0.023***	-0.046***	-0.016***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
D_{Other}	0.041***	0.043***	0.028**	0.038***	0.014	0.020**
	(0.008)	(0.007)	(0.012)	(0.011)	(0.010)	(0.009)
Log. Length Desc.	0.193***	0.138***	0.214***	0.151***	0.132***	0.099***
	(0.003)	(0.003)	(0.006)	(0.005)	(0.004)	(0.004)
Log. Size (in KB)	0.039***	0.029***	0.069***	0.057***	0.035***	0.030***
	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)
Number Screenshots	0.058***	0.057***	0.070***	0.065***	0.040***	0.041***
	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)
Dummy: Video	0.131***	0.101***	0.167***	0.110***	0.099***	0.068***
	(0.010)	(0.009)	(0.015)	(0.014)	(0.012)	(0.011)
Log. Average Rating	0.137***	0.140***	0.558***	0.576***	0.316***	0.352***
	(0.006)	(0.005)	(0.017)	(0.015)	(0.014)	(0.012)
Dummy: Top-Dev.	0.558***	0.345***	0.859***	0.644***	0.414***	0.296***
	(0.052)	(0.044)	(0.055)	(0.048)	(0.049)	(0.042)
App Version	0.020***	-0.007***	0.032***	-0.004	0.020***	-0.004
	(0.003)	(0.003)	(0.005)	(0.005)	(0.004)	(0.004)
Log. AppsByDev	-0.091***	-0.068***	-0.128***	-0.094***	-0.083***	-0.064***
	(0.002)	(0.001)	(0.003)	(0.003)	(0.003)	(0.003)
Log. InstByDev	0.134***	0.073***	0.177***	0.094***	0.109***	0.057***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Log. InstByComp	-0.016***	-0.018***	0.010***	0.002	-0.003	-0.008***
	(0.002)	(0.001)	(0.003)	(0.002)	(0.002)	(0.002)
Log. PriceOfComp	0.002***	-0.001**	0.020***	0.012***	0.008***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Log. RatByComp	-0.611***	-0.128***	-0.518***	0.091	-0.354***	0.043
	(0.052)	(0.045)	(0.083)	(0.073)	(0.068)	(0.061)
Min. Android Vers.	0.008	0.145***	-0.001	0.205***	0.024**	0.168***
	(0.009)	(0.008)	(0.015)	(0.013)	(0.012)	(0.011)
Max. Android Vers.	0.138***	0.144***	0.113***	0.149***	0.072***	0.103***
	(0.016)	(0.014)	(0.035)	(0.030)	(0.027)	(0.024)
Constant	-2.777***	-2.924***	-3.228***	-3.462***	-1.535***	-1.906***
	(0.103)	(0.090)	(0.192)	(0.167)	(0.151)	(0.135)
Category	Yes	Yes	Yes	Yes	Yes	Yes
Observations	168767	168767	79847	79847	71421	71421
Mean of dep. Var.	-0.12	-0.12	1.44	1.44	1.09	1.09
SD of dep. Var.	1.23	1.23	1.44	1.44	1.04	1.04
Adjusted R^2	0.231	0.416	0.240	0.409	0.149	0.303

NOTES: The table shows the relationship between the presence of privacy-sensitive permissions and app demand for subsamples of our data where we exclude the tails of the distribution with respect to our dependent variable, i.e. the most and the least successful apps. App demand is measured by the log. number of monthly new ratings of an app. In Columns 1 and 2 we exclude the most succesful apps, i.e. the upper 5 percentiles with respect to the number of new ratings in April 2012. In Columns 3 and 4 we exclude the least successful apps, i.e. those without any new ratings in April 2012. In Columns 5 and 6 we exclude both groups, i.e. the upper 5 percent of most successful apps and those having no new rating in April 2012. In Columns 2, 4 and 6 we add a dummy which is equal to one if the app in the past had accumulated a stock of at least 10000 or more installations and also add an interaction of this dummy with the privacy-dummy. All specifications control for the number of unproblematic permissions ($\#CleanPerm.$). Heteroscedasticity-consistent standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

2.5 AppAnnie.com

Figure B1: Ranking Information on AppAnnie.com in 2016



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