Anticipating Future of Android: Role of Quality Gatekeeping

Abhinay Puvvala
Doctoral Student, Indian Institute of Management Calcutta,
Joka, DH Road, Kolkata – 700104
+91 9748425353
abhinayp08@iimcal.ac.in

Rahul Roy
Professor, Indian Institute of Management Calcutta,
Joka, DH Road, Kolkata – 700104
+91 9432326223
rahul@iimcal.ac.in

Abstract

Android is currently the fastest growing mobile platform. But is the growth sustainable? In a platform users and developers feed each other through a virtuous cycle of network effects. Initially, a small number of quality applications attract users. With user growth developers join in to reap benefits. Growth beyond a point activates balancing forces of questionable quality and results in slowdown and bust. To the gatekeepers, quality threshold is a handle to control the speed of growth. This paper builds a system dynamics model of Android platform where growth enabling forces and balancing forces are represented. It is calibrated with real life data. Policy experiments are carried out with different quality thresholds. These demonstrate that a loosely regulated ecosystem enables initial growth. However when users prefer quality to quantity, as applications are available in plenty, the ecosystem needs to be tightened up to ensure sustained growth.

Keywords: Two sided platforms, Smartphones, Quality Regulation, Policy lever, System Dynamics

Introduction

The growth of smart mobile phones and its operating system has been phenomenal to say the least. It is estimated that worldwide, growing at a compounded annual rate of 46 percent, the count of mobile phones is expected to touch a figure of to 687.9 million units by the end of this year (Reuters 2012). In recent times the growth to a large extent has been fuelled by increasing band width, widening service coverage. The recent addition to this list of growth drivers has been the innovation of wide variety of applications that are offered by independent developers. Worldwide mobile application store downloads have reached 17.7 billion downloads in 2011, a 117 percent increase from an estimated 8.2 billion downloads in 2010, according to Gartner, Inc. By the end of 2014, Gartner forecasts over 185 billion applications will have been downloaded from mobile app stores, since the launch of the first one in July 2008.Worldwide mobile application store revenue has surpassed $15.1 billion in 2011, both from end users buying applications and applications themselves generating advertising revenue for their developers. This is a 190 percent increase from 2010 revenue of $5.2 billion (Gartner Research 2011). Free downloads account for 81 percent of total mobile application store downloads in 2011. This percentage has been decreasing since the first launches in 2008, and Gartner estimates free downloads to increase again from 2012 through 2014. Users will begin paying for more applications as they perceive values in the concept of mobile applications, and they become more trustful of billing mechanisms (Gartner

Research 2011). The growth in application stores' revenue (both from end users buying applications and applications generating advertising revenue for their developers) between 2010 and 2014 is forecast be over 1,000 percent. The rise of the enterprise app store and in general mobile application management are creating opportunities for companies to mobilize their workforce. Recent reports have indicated that the global mobile apps market is expected to be worth $25billion by 2015 (apps-world.net 2012).

While the analysts and market alike is euphoric about this phenomenal boom in the business of smart (mobile) phone operating systems flickers of adverse indications have started appearing in the media. This is raising the specter of a probable bust that is larking in the horizon. This is the background of this paper in which from a system thinking perspective we try to identify mechanism that are possibly driving the growth of a smart phone operating system (OS) and those that could inhibit its growth and may cause its eventual demise and exit. For this study we select Android as the subject. Needless to say that this is an exploratory study, meant for the strategists concerned about the future of Android. The methodology would also be of use to technology academicians who are interested in management of technology that experience high growth.

The paper is organized as follows. In the next section, we discuss network growth in general and look at two different cases of growth Wikipedia and Atari. This is followed by a discussion on the system dynamics model. The model is tuned to replicate the observed growth patterns of Android and iOS for the first thirty months. The same is then used to qualitatively look at scenarios that can emerge when under alternate feedback effects. We simulate the model and elucidate these (feedback) effects to understand the response of the system for prescriptive purposes. Conclusion relooks the study and the paper ends with limitations of the model.

Nature of Two-sided Platform Business

Emergence of the mobile phone application market place where users can download free or against a nominal fee has completely changed the structure of the industry. In the changed scenario the power has shifted away from the device manufacturer and has moved to the operating system provisioner who provides the platform on which application developers and phone users transact to create value for both. For the sake of completeness we discuss the nature of platform business in this section.

Evans and Schmalensee (2010) have stated that it depends on the nature of the network effects linking the platform's two customer groups, the distribution of tastes among potential customers in both groups, and the nature of out-of equilibrium dynamics. They have shown that when participation decisions are easily reversible and a few other standard assumptions are satisfied, platform businesses, which rely on direct or indirect network effects to attract customers, confront demand-side constraints when they are launched that other businesses do not and also they do not involve economies of scale or fixed costs. The emergence of platforms is a unique phenomenon, the presence of network effects (direct or indirect) in these platforms makes it very hard to dislodge after they acquire a critical mass of users. The entry barriers grow very much in tune with the market share of these platforms. The supremacy of firms like Microsoft, Google is largely down to this. (Gawer 2009)

In the case of direct network effects, the basic problem is that the level of participation on the platform affects the quality of the product it offers to participants, and if quality is too low, participation falls, which reduces quality further, and participation declines toward zero. In the case of indirect network effects, participation by each customer group affects the quality of the product experienced by the other group, and, though the dynamics are more complicated, participation levels below critical mass will set off a similar downward spiral. Since new platform businesses face particular difficulties at launch, strategies for deterring their entry by denying them critical mass seem likely to be particularly attractive privately attractive and harmful socially (Evans and Schmalensee 2010). The role of exclusivity restrictions and related strategies would seem to be especially worth investigating.

The Platform Gatekeeper generally holds the bouncer's rights (Strahilovetz 2006) to allow or disallow outside entities into the system. The right to place restrictions on the use of platform, complementors' involvement, platform changes, commercialization of the system rests with the platform owner. The openness of the platform is also a platform owner's prerogative (Boudreau and Hagiu 2009). Extremes in openness can be directly related to the property rights. A Closed system is vertically integrated, owned, proprietary and controlled by a single entity. It is done by patenting, copyrighting the technology (Katz and Shapiro 1986). On the other hand an open system is freely accessible and is not owned or controlled by a single entity (Katz and Shapiro 1994). Most of the platforms have their openness levels lie in between the two extremes. Also platforms keep changing their openness level through policies as they evolve, should they feel the need to tighten or relax the control on the platform.

Multi sided platforms regulate entry to the platforms/interactions between customer groups around the platform by legal, technological, informational and price setting mechanisms (Boudreau and Hagiu 2009). Platforms are likely to weed out the low quality users of the customer group, which is on the opposite side of quality conscious customer group if the exclusion incentives are stronger than the costs associated with exclusion (Hagiu 2011). One of the striking examples of boom followed by bust that would worthwhile to cite in this connection is that of 'the Atari Shock', a case study on 1983 North American Video Gaming Industry Crash (Figure 1).

The North American video game industry, which first began in the late 1970s, went through a rise, fall and rise again within a very short span of time. The Atari Corporation, which pioneered home video games, emerged as the dominant game system manufacturer of the young industry. The tremendous success of the industry in general and Atari in particular, can be gauged from the fact that at its peak, Atari was the fastest-growing company in the history of the United States at the time. By 1982, retail sales of home video games in the United States touched $3 billion, and Atari sold more than $5 billion worth of 2600 systems and products by 1983. However, this rapid growth was halted in 1983 by what later came to be known as "the Atari shock". This North American video game crash of 1983 was later largely attributed to the lemons' market failure (Refer to Figure 2). Atari had always followed the strategy of out-innovating the competition, that is, instead of deterring imitators, Atari just produced games faster than the competitors could imitate, leading it to be always one step ahead.

However, because it had not developed a technology for locking out unauthorized games, Atari was unable to prevent the entry of opportunistic developers, who flooded the market with poor-quality games. At that time, in the absence of easily accessible user reviews, the only way to find out whether a new game was good was to try it yourself. Since the market was flooded with poor quality games, Atari's customers experienced dissatisfaction often, leading them to lose trust in the home video game industry.

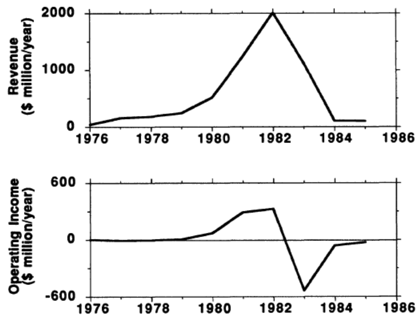


Figure 1: Sales and Operating Income of Atari, Inc. (Paich and Sterman 1993)

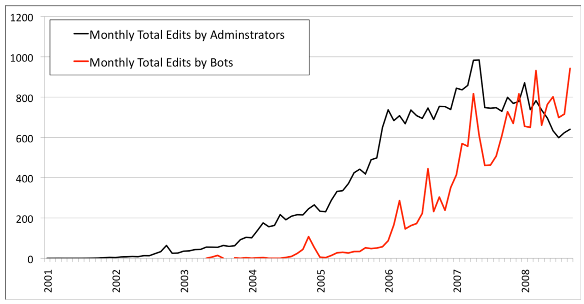


Figure 2: Wikipedia edits (Suh 2009)

On the other hand, game designers at Atari were dissenting because they were not given authorial credit or royalties for their work. Hence, many of Atari's programmers left to form their own companies, spawning more competition for Atari, and leaving uninformed consumers with several choices. All this led to the collapse of the videogame market in the USA and drove more than 90 percent of game developers to bankruptcy, including Atari, manufacturer of the dominant game console at the time. Video game sales dropped from $3 billion in 1982 to as low as $100 million in 1985.

The video game crash of 1983 was a uniquely American phenomenon. In hindsight, it was seen that the crash simply resulted in the shifting the centre of the video gaming industry from America to Japan. Nintendo was experiencing great successes in the Japanese video game industry. After the North American video game crash of 1983, Nintendo entered the US markets, but in a significantly different manner than Atari. To convince the reluctant retailers to stock their products, the console was designed with a front-loading cartridge slot to make it look more like a VCR than a game console. Another major change was that Nintendo cartridges were equipped with a "security chip", to prevent the cartridges that were not approved by Nintendo from running on the system. This brought in an element of quality control, the absence of which was thought to be the reason behind the earlier crash.

The game designs were first submitted by the developers to Nintendo for approval. The game cartridges of approved designs were then manufactured by Nintendo's own contract manufacturers. Nintendo could thus carefully control both the quality of games offered for its system and the rate at which they were offered. By 1990, Nintendomania ensured that Nintendo became the undisputed market leader. The Atari-Nintendo story shows how quality regulation, plays an important role in the evolution of multi sided platforms.

Wikipedia is a similar example of a socio-technical system where the initial exponential growth slowed down and stabilized in later period. Wikipedia, one of the world's largest aggregators and the largest public collection of encyclopedic knowledge, has a growth like natural populations. Wikis are an example of community technology platform (Dutta, Roy and Seetharaman 2008) but owing to evidence of competition and dominance, this growth is increasingly getting constrained. Wikipedia has exponential growth because the growth of content and editors in Wikipedia has been exponential in nature; however, recently this growth has slowed down, perhaps plateaued (Suh 2009). The rate of both page and editor growth has declined mainly due to increased coordination and overhead costs, exclusion of new editors and increased resistance to new edits. The limited opportunity for contribution (article growth peaked in 2007-08) and influence of administrators on content production has declines steadily. Large influx of poor quality articles also reduces readership and inclination to contribute; un-authoritative and unreliable sources of information also lead to declining growth. Thus, there is overall slowdown in the global editing activity of Wikipedia; the community itself having adopted a logistic growth model (a special case of S-shaped growth) rather than an exponential one.

Prolific editors tend to experience lesser rate of reverts per edits when compared to occasional editors. The number of blocks and deleted pages increased. The governance structure has been changed - Policies have been more restrictive, amount of work on improving coordination/ community bureaucracy has gone up which can be seen as overhead costs to the community. That had a negative impact on content production because (a) they take efforts away from the direct work on content and (b) it may affect the motivation of the contributors. As the number of such easy topics gradually diminishes, the competition on the remaining few increases (Suh 2009).

In this paper, we try to identify mechanism of quality impacting the platform growth, which is different from the dynamics identified in the existing literature that majorly deals with the impact of quality on the consumer side alone. Also earlier models focused on single platforms and not duopolies or competition between platforms.

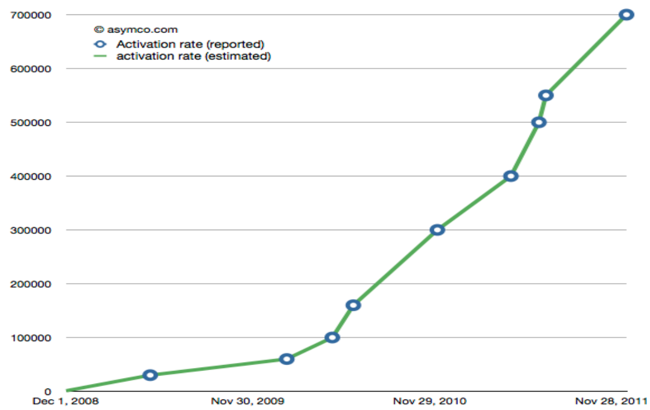


Figure 3: Android Daily Activation Rate (Asymco 2011)

Android – Market and Its Growth

Android, a Linux-based operating system is used for mobile devices such as tablet computers and smartphones. It is developed by the Open Handset Alliance in alliance with Google and other companies. The source code is available under free and open source software licenses. To use the Android trademark, device manufacturers must ensure that the device complies with the Compatibility Definition Document (CDD) and then get permission from Google (Open Handset Alliance 2012). Devices should meet this criterion to be able to license Google's closed-source applications. Android breaks down these barriers to build innovative applications. For example, a developer may combine information with data on an individual's mobile phone to provide a better user experience. There is no differentiation between the phone's core applications and third-party applications in Android. To provide users with a broad spectrum of applications, all are built to have equal access to a phone's capabilities. For Android devices, users can fully tailor the phone according to their interests. Android enables developers to create mobile applications that make use of all the advantages of a handset. It was built to be truly open (Open Handset Alliance 2012).

Canalys tracked in 56 countries that Android has a global market share of 48% (Android led in 35 of them). Android which is the number one platform by shipments since Q4 2010, had shipments up 379% (Canalys 2011). Initially, the rate of growth of worldwide shipments for Android phones was 886% - Nielsen report. At the end of Q2 2011, Larry Page disclosed that Android had been growing at 4.4% week-over-week. Dell, HTC, Kyocera, LG, Motorola, and Samsung are together making 42 smart phones using the Android OS. The Android OS accounted for 52.5% of smartphone sales to end users in the Q3 of 2011 (Gartner Research 2011), which was more than double its market share from the Q3 of 2010. Android's mass-market offerings and weaker competitive environment (lack of innovative products on other OS such as Windows Phone 7 and Research in Motion) proved beneficial for them. (Reisinger 2011).

In March'12, Google removed the Android concept and launched Google Play, which merges its app store with its Google Music and eBookstore. Google Play features more than 450,000 apps and games along with millions of songs and movies, all in one. "Google Play is entirely cloud-based so all your music, movies, books and apps are stored online, always available to you, and you never have to worry about losing them or moving them again," said Jamie Rosenberg, Google's director of digital content. Android devices have 48.6% of the U.S. smartphone market, more than Apple's rival iOS which has 29.5%. However, Android applications related consumer choice is behind the excitement for iOS apps and games. By March'12, Apple announced that its developer payments exceeded $4 billion dollars where as Android could only generate 7% of it for its developers since the launch of its application store (Ankeny 2012). The expected developer payoffs are going to play a major role in the future growth of Android. According to Piper Jaffray reports (November 2011), Android roughly 10-15% market share in dollars spent on mobile applications (Ankeny 2011).

Android's Growth Predictions (Gompretz/Bass Diffusion/Logistic Growth Models)

Apps	**Gompretz**	**Logistic Curve**	**Bass Model**
Mean Absolute Percentage Error	10.74%	18.16%	593.25%
R-Square	99.61%	98.18%	64.68%
Mean	115,058.08	115,058.08	115,058.08
Standard Deviation	124,824.64	124,824.64	124,824.64

We used few empirical growth models and tried to fit in the observed data to examine the future growth. Gompretz curve, Bass diffusion model and Logistic growth curve have been employed on both complementary goods and sales of Android. The fits for Gompretz and Logistic growth curves have been good in both the cases, whereas the R2 values for Bass diffusion model are not as good as the other two.

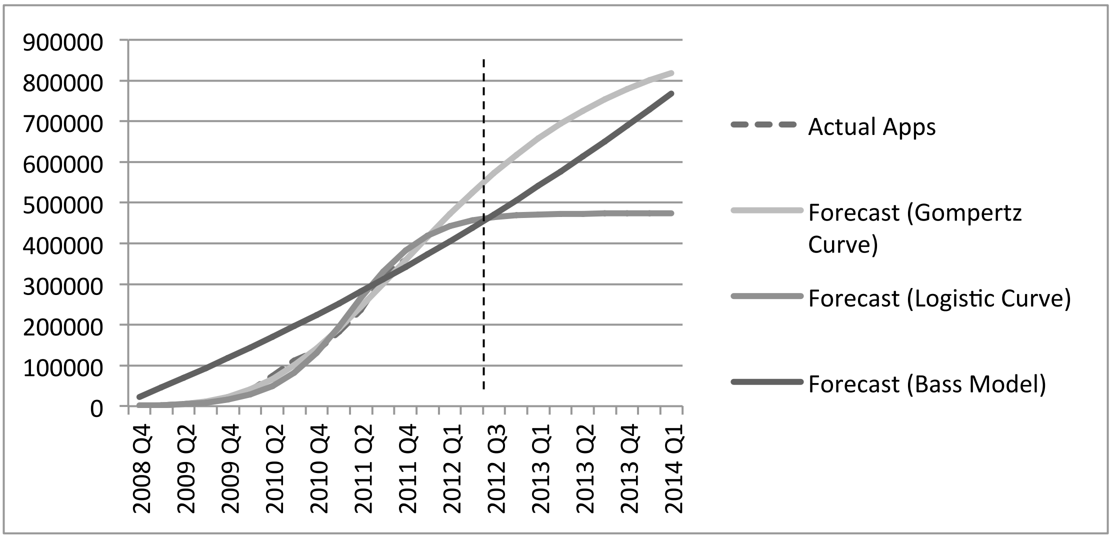


Figure 5: Apps Growth

Similar analysis was conducted on Sales data and the results are summarized in the table and chart below.

Sales	Gompretz	Logistic Curve	Bass Model
Mean Absolute Percentage	21.52%	18.57%	486.57%
R-Square	99.48%	97.25%	64.15%
Mean	22,623,076.92	22,623,076.92	22,623,076.92
Standard Deviation	25,534,948.40	25,534,948.40	25,534,948.40

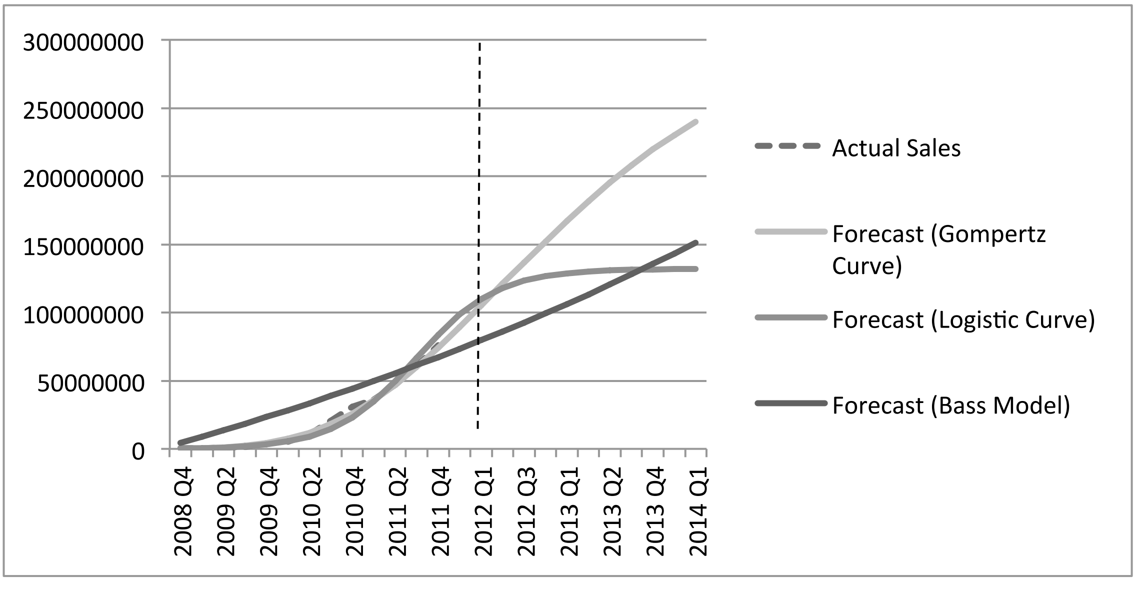


Figure 6: Sales Growth

Inadequacy of Diffusion models

Diffusion models make predictions based on observed past behavior and generalized assumptions about growth that are specific to each model. There are number of diffusion models that can replicate the boom and even stabilization phases of a product diffusion. But these models cannot predict a bust phase. Given a diffusion process of interest, the forecaster has to choose an appropriate stochastic model. However, that a range of models is necessary to capture the wide variety of practical realizations of the diffusion process. The models differ in shape and in the way randomness is incorporated. In a highly dynamic setup like that of a two sided market platforms, it is even more difficult to predict the future growth patterns by diffusion models. To illustrate, we have taken the case of VHS vs. Betamax format war. VHS and Betamax are two similar but incompatible home cassette recorder formats. They also are two sided platforms and exbhit indirect network effects like smartphone platforms. VHS was introduced by JVC in 1976 and supported by JVC's parent company Matsushita Electric. Sony Corporation brought Betamax into VCR market in 1975. As is the case with all the products that have network effects, success in this case was also dependent on the common format used by majority of VCRs. We then looked at the sales of Betamax over a period of 14 years and of which 10 years sales data has been used as input to the three growth models used in previous section. Predicted and Observed patterns of data have been compared to illustrate the inadequacy of growth models as shown in Figure 7. Also the bust behavior is very difficult to capture from these models. It is evident that all the diffusion models fell short of predicting the evolution of Betamax.

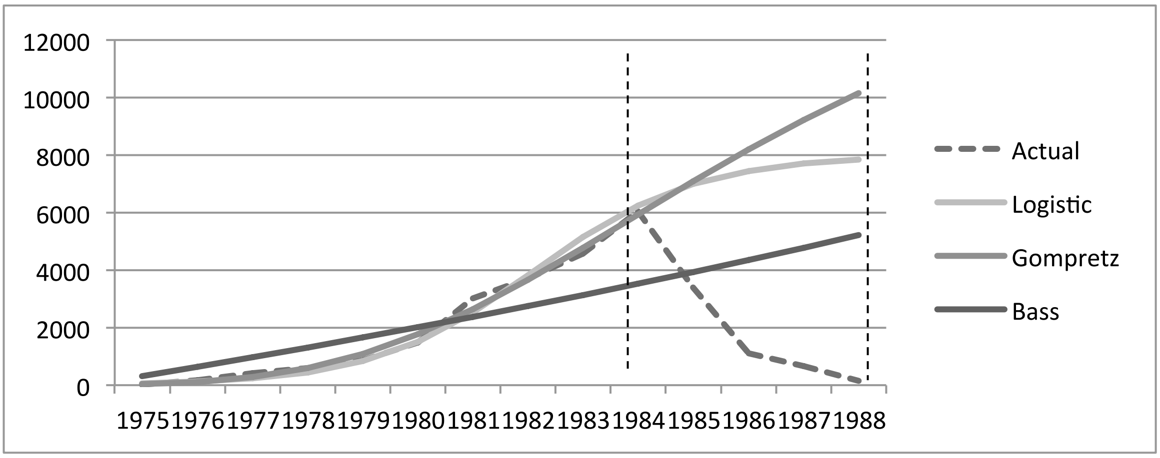


Figure 7: Betamax Sales

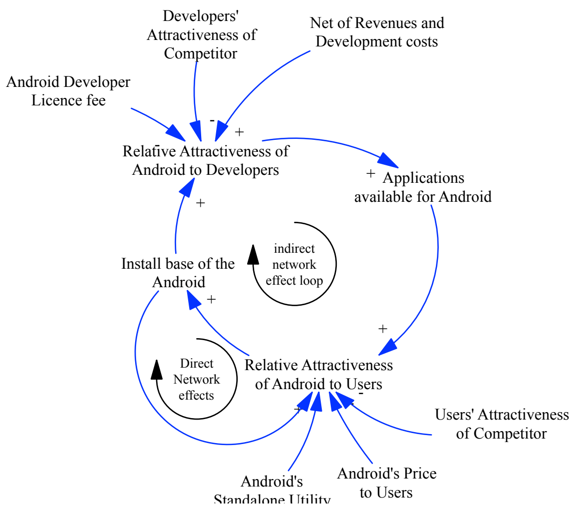


Figure 2: Direct/Indirect Network Effects

Model of Android Growth Dynamics

We choose the methodology of System Dynamics (Sterman 2000) to model the complex growth dynamics of platform business. System Dynamics methodology is a mathematical language used to represent various influences in a system and has been extensively used in numerous application domains. The fundamental premise of System Dynamics is that structure determines behavior. Here structure is embodied by the cause-effect feedback loops that connect different elements of a system. Each loop is characterized by its polarity (positive or negative) depending on the type of feedback effect (reinforcing/balancing) that it generates. Further, a reinforcing loop, which generate exponential growth over time while a negative loop generate a self-stabilizing behavior over time. By studying the feedback leads one to visualize the probable time path of behavior for the system. In follow up steps the feedback loops are converted into a system of linear difference equation. These equations are numerically integrated to generate pattern and performance of what-if analysis.

In the case of most platforms, the utility derived from the product depends on the complementary goods available (indirect network effect) and the number of users on the same platform (direct network effects). Every additional complementary good available generates a new service when used along with the platform. Also every additional user on the platform generates additional utility derived from compatibility and networking. In mobile platforms, there is a strong presence of indirect effects; availability of applications that are compatible with the platform is critical for a sustainable growth of a mobile platform. Direct network effects in mobile platforms may not be as prevalent as they are on other platforms, nevertheless they do exist due to some of the cross platform compatibility constraints imposed by the platform gatekeepers. On the other side of platform, developers make their decisions based on their expectation of market potential, development costs of a platform. Market potential closely follows the number of platform users, which completes the indirect network effects loop.

As shown in figure 2, the attractiveness of the product is influenced by the two reinforcing loops – Direct and indirect network effects. There are a many examples of technology platforms that hugely benefitted by the lock in generated by these loops. Wintel, Google, Atari, Bluray, VCR are some of them.

Application Quality

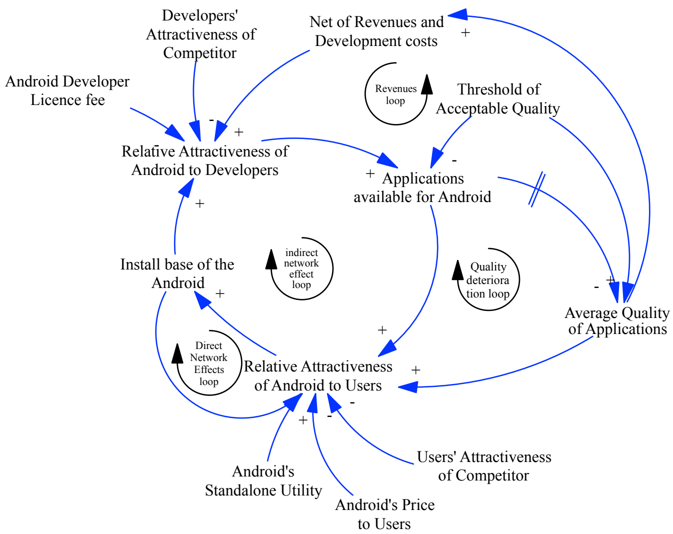
As discussed above, in the case of Atari's failure and the subsequent revival of North American gaming industry by Nintendo, the use of security chip to weed out any game not approved by Nintendo was critical to success. Openness can foster innovation but in a longer run, it can prove detrimental to platform's growth. The characteristics of Multi Sided Platforms are such that it becomes essential for Platform gatekeeper to take up counterintuitive measures like restricting access to promote growth in certain cases.
Currently, smartphone platforms seem to treading the same path of Atari and Nintendo. Apple actively uses its right to exclude any third party application it did not deem appropriate from its application store. Whereas Android seems to activate every app submission from developers.
An independent Android application rating agency, Appbrain, which observes the quality of applications in Android market, has released trends that point towards a steady increase of poor quality applications in the app store.

"*The open nature of the Android Market is adversely affecting the overall quality of apps and causing users to return large numbers of Motorola devices. For power consumption and CPU use, those apps are not tested. We're beginning to understand the impact that has,*" Motorola chief executive, Sanjay Jha (CNET UK, 2012).

Similarly, there are concerns raised by application developers and tech analysts about the current Android's regulatory procedure.

With widely available reviews and ratings available from rating agencies and different intermediaries, lemons problem has become a lesser influence on the sales of smartphones. But the quality or the lack of it still has crucial role to play in influencing the developer revenues loop. As mentioned earlier, paid application downloads on iOS are more than 10 times that of Android according to different reports (Ankeny 2012). User confidence on paid applications is driven by the average quality of applications. This user confidence drives the developer payoffs, which are crucial to the success or failure of complementary goods growth and eventually the platform growth. Rest of the paper builds, predicts and analyses Android's evolution under different policy experiments at various quality thresholds.

Figure 4: Feedback Structure of Mobile Platforms



We now build a system dynamics model with application quality as an endogenous variable. Building on the basic causal loop diagram (figure 2) by adding application quality transforms the model as in Figure 4. We also take a duopoly assumption to replicate the current smartphone market setup, for the dynamics of Android platform growth. The platform connects two customer groups and the platform (sponsor/gatekeeper). The important system elements are users, developers, applications, average quality, and attractiveness of the platform. Like any platform that involves two sided markets, indirect network effects form the principal influence in the causal structure. Indirect network effects make participation more attractive to each individual as more individuals in the customer group on the other side of the platform participate. This influence is represented by 'Indirect network effect loop' in Figure 4. More developers' attractiveness implies greater base of complementary goods (applications), which improve the network attractiveness for the users and encourage further network growth by improving the attractiveness for complementors. With all other mechanisms dormant, this loop should result in an exponential behavior, which possibly explains the Android's initial growth phenomenon.

There are two balancing loops, which counter this growth: Quality deterioration loop, with a rise in the install base, more and more developers who are not capable of producing good quality applications get attracted to the platform, which deteriorates the average quality of applications that in turn negatively impacts the attractiveness to users. Revenues loop, with a drop in average quality, users will be wary of downloading applications resulting in a reduction in the net of revenues and development costs, this in turn reduces the attractiveness for developers to come in and produce applications for the platform. With a finite life for applications, slowly the application base will shrink and the platform will meet its natural death. It may be noted that quality threshold moderates both these loops and therefore is an important handle for the policy makers. The moderation effects of quality threshold are however different in the two loops. The behavior of the system therefore is dependent on which of these two loops are stronger.

Our SFD consists of three sectors - Complementary Goods, Users & Average Quality Co-flow Structure.

Complementary goods sector as the name suggests models the dynamics behind the application development. Developers make choices based on parameters like Platform Entry Price (Developer License fee), Install base (market for the application), Development and Porting Costs, Expected Revenues and the Relative Attractiveness of the platform. Developers' multi-homing (hosting their applications on both the platforms) has also been included in the causal structure (Hagiu 2011).

Developer's Utility *= Indirect Network effect Parameter for complementors * Install Base of the Platform – Platform Entry Price – Net of Development / Porting Costs and Expected Revenues*

Users sector models the dynamics behind sales of smartphones. Users' decision is based upon variables like Standalone Utility of the Platform (Utility derived from the smartphone alone), Product price, Average quality of complementary goods, Complementary goods base (Indirect network effects) and the relative attractiveness of the platform for users. We have assumed that there is no multi-homing in this customer group (Hagiu 2011).

Users' Utility *= Standalone utility+ Indirect Network effect parameter for users * Complementary goods base – Price of the product*

Average quality Co-flow structure is for capturing the average quality of complementary goods base. Co-flows are used to account for the attributes of items flowing through a stock and flow network. The outflow rates of items from a stock often depend strongly on the age of the items (Sterman 2000).

Average Quality(t) *= (Production of Complementary Goods(t)*((100*(1+Quality Threshold(t))+1)/2)-((100*(1+ Quality Threshold(t-δ)+1)/2)* Production of Complementary Goods(t-δ))/Complementary Goods(t)*

δ = Average Life of Complementary Goods

Predicting Patterns of Evolution

The causal structure in Figure 4 along with the corresponding structure for the competitor has been converted into the corresponding mathematical model. Developers' choice is a function of Platform Entry Price (Developer License fee), Install base (market for the application), Development and Porting Costs, Expected Revenues and the Relative Attractiveness of the platform in accordance with (Hagiu 2011). Users' decision is a function of Standalone Utility of the Platform (Utility derived from the smartphone alone), Product price, Average quality of complementary goods, Complementary goods base (Indirect network effects) and the relative attractiveness of the platform for users is also accordance with (Hagiu 2011). We have assumed that there is no multi-homing in this customer group. We calculate the Average Quality based on the assumption that quality of complementary goods follows uniform random distribution. The model parameters have been tuned to mimic the observed behavior of Android and iOS' growth for the first 30 months post launch of iOS appstore. The model parameters are reproduced in Table1. The output of the tuned model appears in figure 5.

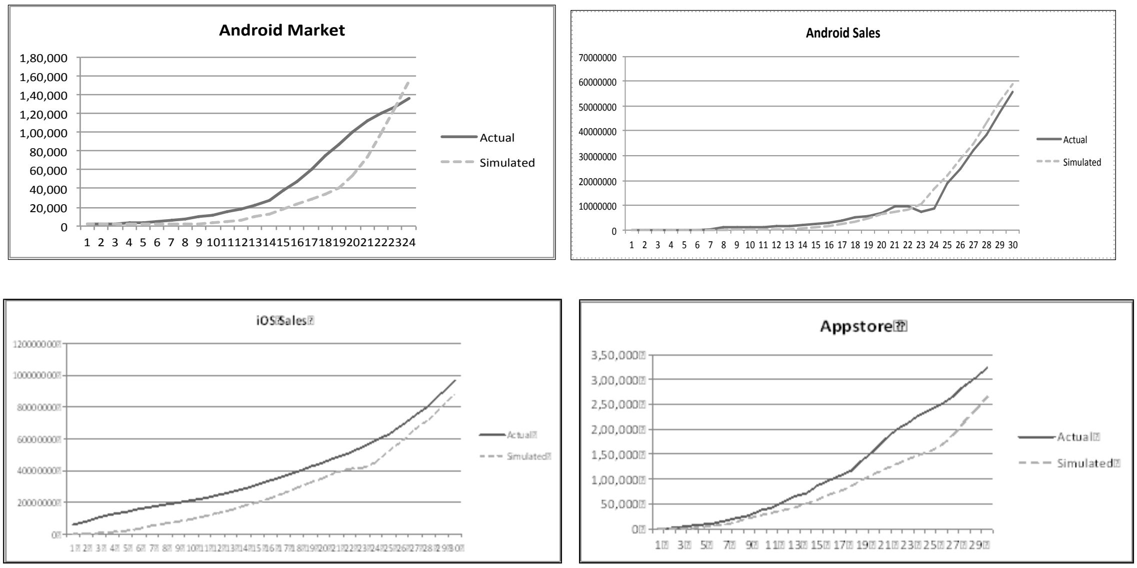


Table 1: Parameters

Parameter	Value
Sensitivity of Attractiveness to Installed base	2.5
Gradient of impact of Average Quality on Developer returns	5
Q_{iOS}	10%
Q_{and}	2%
Smoothing interval for Sensitivity of Attractiveness to Complementary	10
Gradient of exponential impact of Complementary goods on Users	0.1
Gradient of exponential quality drop/rise with rise/drop in quantity	0.01

Policy experiments have been conducted on the model and the growth of Android platform over the next 30 months (t=30 to 60) has been analyzed. The objective of this exercise is to demonstrate the model's ability for conducting what-if scenario analysis and predictive purposes. The scenarios generated here correspond to the changes in the quality regulation by both the platform gatekeepers. Five different scenarios starting January 2011 have been looked at, each with different set of quality regulations. Figure 6 shows the behavior of the model in response to various levels of quality regulation employed by the platform gatekeepers. The policy experiments conducted are summarized in the table below.

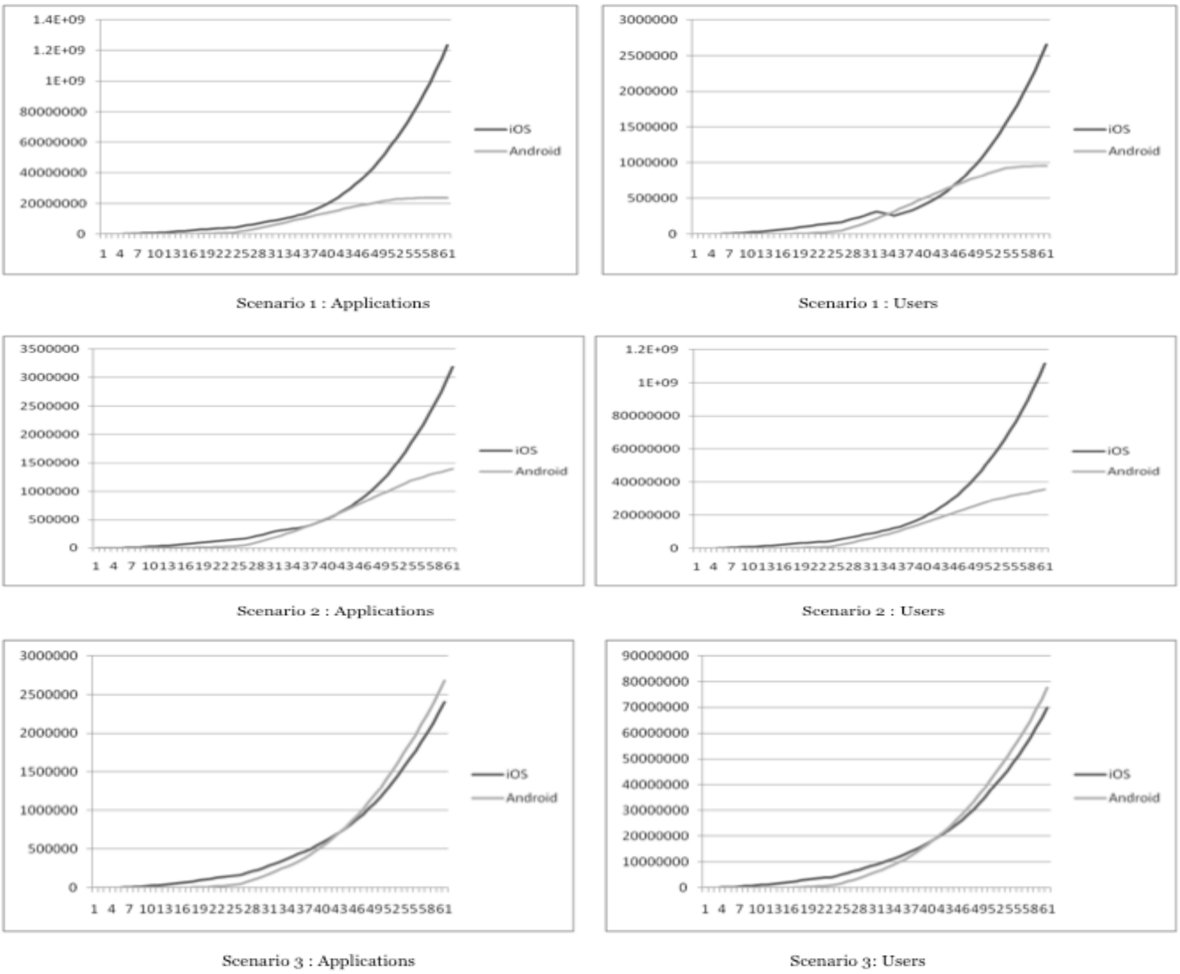
Table 2: Summary of policy experiments

Policy	**Parameter Change**		**Android**		**iOS**	
			Users	Applications	Users	Applications
Base Case	Q_{and} Q_{ios}	- -	702151680	2553677	771857280	2520252
Scenario 1	Q_{and}	-	238008672	962182	1236000256	2654949

	Q_{ios}	+30%				
Scenario 2	Q_{and} Q_{ios}	- +10%	357994976	1392053	1116013824	3188621
Scenario 3	Q_{and} Q_{ios}	-4% +4%	2679112	776319744	697689152	2402608
Scenario 4	Q_{and} Q_{ios}	+10% -	809846336	2608178	664162752	2198174
Scenario 5	Q_{and} Q_{ios}	+30% -	1054463104	2593228	419545920	1433885

The outputs of different scenarios are shown below.

Figure 6: Policy Experiments



Scenario 1 : Applications

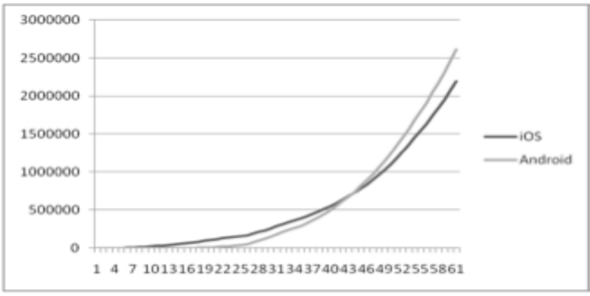
Scenario 1 : Users

Scenario 2 : Applications

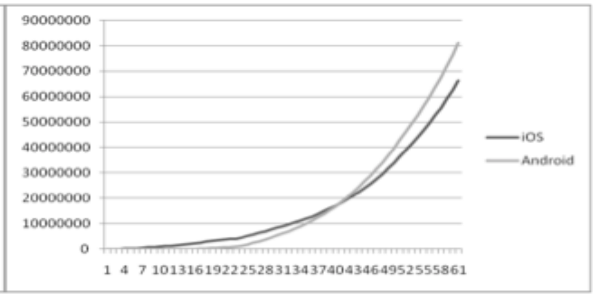
Scenario 2 : Users

Scenario 3 : Applications

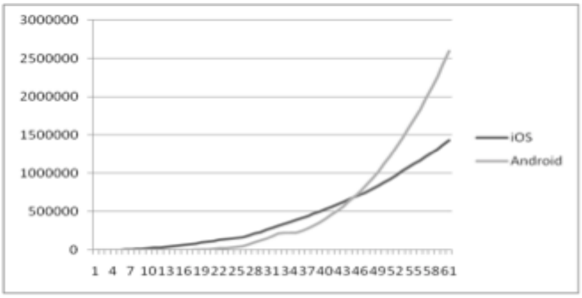
Scenario 3: Users



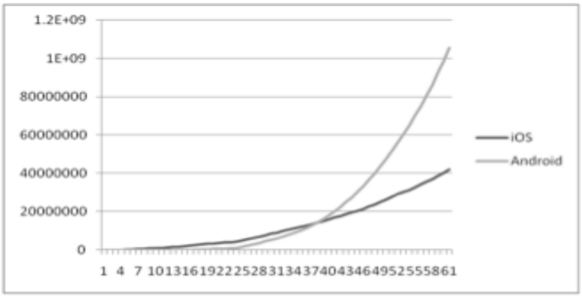
Scenario 4: Applications



Scenario 4: Users



Scenario 5 : Applications



Scenario 5: Users

The first policy (scenario 1 in Table 2) reduces the number of low quality applications through an increase in quality threshold for iOS platform. Doing this leads to rejection of many complementary goods by the platform gatekeeper and slower growth in the short run, but this in turn improves the average quality of complementary goods of the platform. In the long run, the strategy makes an improvement (see the users/applications of iOS in Table 2) in the overall platform value because the intrinsic growth of quality conscious users loop—users after a threshold of complementary goods tend to give more importance to quality rather than quantity—weakens the negative effect of the increased regulation and costs of exclusion. Comparable results are achieved in other policy experiments as well. The third policy (scenario3 in Table 2) shows interesting results. Android phones entered the market roughly 7 months after the launch of Appstore, which was an attempt by Apple to use the third party innovation and with the help of indirect network effects to strengthen its market leadership. By the time Android phones entered the market, it had a disadvantage of 1561 to 16,559 application base against it, along with 17377000 iPhones in the market. Google had to a lot of things differently to overcome this inherent disadvantage. Opening up the platform, loosely structured environment, cross subsidizing by freely allowing the access to OS and only charging the developers fee are few of the prominent strategies. The scenario 3 and the base run emphasize the following hypotheses 1. A loosely structured (not strongly regulated) ecosystem fastens the initial growth of the platform 2. As platforms grow, their ecosystem needs to be tightened up to increase the value of the platform

Discussion and Conclusion

The essence of this study can be captured in a simple question: How can Google, ensure a sustained future for Android market? The highly dynamic nature of two sided markets leads to uncertainties in the outcomes of policy changes. The paper tries to look at the policy, which involves screening of applications based on measure of quality by the platform gatekeeper.

Android so far has adopted the same rapid growth like Atari. However, from here on, Android growth could well hit a plateau or show boom and bust behavior of Atari. The driver to either of these growth patterns could well be the quality of complementary goods. The platform gatekeeper monitors the average quality of the complementary goods by setting the quality threshold, based on some measure of quality and screens applications accordingly. In the presence of indirect network effects, a high quality threshold slows down applications' growth and renders the platform unattractive to prospective users. Also by restricted access would result in the exclusion of developers who would otherwise be prepared to pay the license fee/share of sales. A low threshold on the other hand leads to a very high volume of applications in the long run, and low quality of applications. It is known that when availability is abundant the relative importance to quality and quantity falls in favor of quality. Low quality could thus frustrate users and induce them to move to competing platform. In this process platform gatekeeper faces the task of choosing the right level of quality threshold and different stages of platform growth. The model proposed in the paper could help the gatekeeper in this.

Based on the simulated dynamic behavioral pattern and a study of the data we can offer the following comments on loop dominance - Attractiveness to users is being influenced by two variables, which change over time (in the current run) – Complementary goods and Sensitivity of Attractiveness to Complementary goods. Sensitivity of Attractiveness is directly influenced by the average quality, which drops to a minimum of quality threshold as number of complementary goods rise. Initially, Attractiveness is being strongly influenced by the rise in complementary goods than the relative drop in average quality but as the influence of average quality on complementary goods and sensitivity of Attractiveness to complementary goods grows the Attractiveness drops and so does the user base of the platform. The fall in attractiveness starts with the start of obsolescence of complementary goods (a stock out flux, which remains zero until the average life of complementary goods). Attractiveness to Complementors is being influenced by two variables, which change over time (in the current run) – Install base and Development and Porting Costs. Both of these variables are influenced by Average quality, which in turn is influenced by changes in complementary goods over time. Development and Porting Costs are negatively influenced by the Average quality. The Development and Porting costs loop dominates the Attractiveness variable at the onset of useful life of products. Till then the influence of Install base dominates the Attractiveness.

The treatment of this paper has intentionally not been prescriptive and also, the model is not predictive in any way. However, the literature review, the results of the causal loop diagram and the graphical results of the policy experiments; all point towards a possible eventuality. The model wherein initially there is a loose ecosystem, which tightens after being established with a critical mass/estimated threshold value, seems to be sustainable, wherein the quality thresholds implemented by the gatekeepers can in a way convey the looseness or tightness of the system.

Our model's causal structure is broadly based on the literature on quality regulation in multi sided platforms. Our model is not foreign to the obvious shortcomings that come with the level of aggregation in system dynamics modeling. The utility functions of users and developers all hover around the averages based on different dependencies and distributions assumed, however in reality the interaction of these different utilities may lead to a completely different emergent phenomenon. Also the paper assumes that there is a measurable parameter for quality on which regulation can be done, but in truth quality is a complex and possibly an unobservable parameter by a single agent.

References

Strahilovetz. "Information asymmetries and the rights to exclude." *Michigan Law Rev*. 104, no. 8 (2006): 1834–1898.

Katz, M, and C. Shapiro. "echnological adoption in the presence of network externalities." *Journal of Political Econom*. 94, no. 4 (1986): 822–841.

Katz, M, and C. Shapiro. "Systems competition and network effects." *Political Econom*. 8, no. 2 (1994): 93-115.

Boudreau, K, and A Hagiu. "Platform rules: Multi-sided platforms as regulators." In *Platforms, Markets and Innovation*, edited by A. Gawer, 163–191. Edward Elgar, 2009.

Gartner Research. *Gartner Says Worldwide Mobile Application Store Revenue Forecast to Surpass $15 Billion*. Egham, UK: Gartner, 2011.

apps-world.net. *The rise of the Enterprise Apps Store*. http://www.apps-world.net/blog/2012/02/europe/the-rise-of-the-enterprise-apps-store/#more-1576, 2012.

Canalys. *Android takes almost 50% share of worldwide smart phone market*. http://www.canalys.com/newsroom/android-takes-almost-50-share-worldwide-smart-phone-market, 2011.

Asymco. *How many Android phones have been activated?* http://www.asymco.com/2011/12/21/how-many-android-phones-have-been-activated/, 2011.

Open Handset Alliance. *Android Overview*. http://www.openhandsetalliance.com/android_overview.html, 2012.

Wikipedia. *Android (Operating System)*. http://en.wikipedia.org/wiki/Android_(operating_system), 2012.

Coyle, R. "The practice of systems dynamics: milestones, lessons and ideas from 30 years of experience." *System Dynamics Review* 14, no. 4 (1998): 343-365.

Forrester, J.W. *Industrial Dynamics*. Cambridge, MA: MIT Press, 1961.

Richardson, G. *Modeling for Management* . Aldershot: Dartmouth Publishing Co.,, 1996.

Coyle, J.M., D. Exelby, and J Holt. "System dynamics in defence analysis: Some case studies." *The Journal of the Operational Research Society* (Oxford) 50, no. 4 (Apr 1999).

Dutta, A, R Roy, and P Seetharaman. “Wikipedia Usage Patterns: The Dynamics of Growth.” *Twenty Ninth ICIS* . Paris, 2008.

Sterman, John D. "Coflows and Aging Chains." In *Business Dynamics: Systems Thinking and Modelling for a Complex World*, by John D. Sterman, 469-513. McGraw-Hill , 2000.

Suh, B, Convertine, G. Chi, E.H., Pirolli, P. “The Singularity is not near: Slowing growth of Wikipedia.” *WikiSym - ACM*, 2009: 978-1-60558-730-1.

Reisinger, Don. *Android smartphone share more than triples iOS in Q3*. http://news.cnet.com/8301-13506_3-57324963-17/android-smartphone-share-more-than-triples-ios-in-q3/, 2011.

Raman, Sandhya. *Google scraps Android Market, reveals Google Play*. http://www.fiercemobilecontent.com/story/google-scraps-android-market-reveals-google-play/2012-03-06, 2012.

Albright, Peggy. *Research: App stores have reached saturation point*. http://www.fiercedeveloper.com/story/research-app-stores-have-reached-saturation-point/2012-04-02, 2012.

Hagiu, Andrei. "Quantity vs. Quality: Exclusion By Platforms With Network Effects ." Harvard Business School, March 14, 2011.

Boudreau, Kevin J, and Andrei Hagiu. "Platform rules: multi-sided platforms as regulators ." In *Platforms, Markets and Innovation* , edited by Annabelle Gawer, 163-192. Cheltenham: Edward Elgar, 2009.

Evans, D.S., and R. Schmalensee. “Failure to Launch: Critical Mass in Platform Business.” *Review of Network Economics*, 2010: Volume 9, Issue 4.

Paich, M., and J.D. Sterman. “Boom, Bust and Failures to learn Experimental Markets.” *Management Science*, 1993: 1439-1458.

Pavlov, Oleg V., and Khalid Saeed. "A resource-based analysis of peer-to-peer technology." *System Dynamics Review* (Wiley InterScience) 20, no. 3 (Fall 2004): 237-262.

Gawer, Annabelle, ed. *Platforms, Markets and Innovation*. Cheltenham: Edward Elgar, 2009.

Reuters. *Reuters*. 04 12, 2012. http://www.reuters.com/article/2012/04/12/us-smartphonemakers-research-creditsuiss-idUSBRE83B0LS20120412 (accessed 05 02, 2012).

Ankeny, Jason. *Android Market makeover can't hide fatal flaws* . March 12, 2012. http://www.fiercedeveloper.com/story/android-market-makeover-cant-hide-fatal-flaws/2012-03-12 (accessed May 2, 2012).

—. *Can developers make money in Android Market?* . 11 11, 2011. http://www.fiercedeveloper.com/story/can-developers-make-money-android-market/2011-11-21 (accessed 05 02, 2012).