# A DYNAMIC INTERACTIVE SIMULATOR FOR COMPETITIVE MANAGEMENT IN MOBILE COMMUNICATIONS MARKET

by

Mehmet Serdar Çakacıaslan

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## ABSTRACT

## A DYNAMIC INTERACTIVE SIMULATOR FOR COMPETITIVE MANAGEMENT IN MOBILE COMMUNICATIONS MARKET

In this research, market share competition between two firms in mobile telecommunication industry is examined. Companies' decisions on pricing and investment strategies affect each other and create complex dynamic behaviors for market structures. Contrary to most economic theories, firms in reality make sub-optimal decisions in response to a competitors'. In this context, feedback mechanisms exist between the decision making processes of the parties. System dynamics methodology is thus suitable to model and investigate the complex dynamics of mobile communications market. An oligopoly market is assumed where two major competing firms are explicitly modeled. To reveal insights about the market dynamics, a simulation model is built and analyzed under different scenarios to ensure the realism and validity of the model. Finally, a web-based interactive simulation game is designed where a player periodically makes eight strategic decisions, such as price, service and features investments and advertising. The counterpart decisions for the competitor firm are accordingly made by the decision rules in the simulator. The purpose of the player is to maximize some performance measures like profits, revenues and market share. Experiments and extensive tests with the interactive game indicate that it is a promising tool for real-life decision makers to test their business strategies against a competitor.

# ÖZET

## MOBIL İLETİŞİM SERVİS SEKTÖRÜNDE REKABETÇİ YÖNETİM İÇİN ETKİLEŞİMLİ BENZETİM MODELİ

Bu araştırmada, mobil iletişim sektöründeki iki firma arasındaki pazar payı rekabeti incelenmiştir. Şirketlerin fiyatlandırma ve yatırım stratejileri üstündeki kararları, birbirlerini etkilemekte ve piyasa yapılanmasında anlaşılması güç, zamanla değişen davranışlar ortaya çıkarmaktadır. Çoğu ekonomik teorinin aksine, firmalar gerçek hayatta rakiplerinin kararları karşısında en doğru kararları alamazlar. Bu bağlamda, tarafların karar verme süreçleri arasında geri bildirim mekanizmaları ortaya çıkmaktadır. Bu nedenle, sistem dinamiği yöntemi, mobil iletişim pazarının karmaşık dinamiklerinin modellenmesi ve incelemesi için uygundur. Modellemede, oligopol bir piyasada, iki ana firmanın rekabet ettiği varsayılmıştır. Piyasa dinamikleri hakkındaki iç görüleri ortaya çıkarmak için, bir benzetim modeli kurulmuştur ve modelin gerçekliğinin ve geçerliliğinin test edilebilmesi için farklı senaryolarla analiz edilmiştir. Son olarak, bir oyuncunun periyodik olarak; fiyatlandırma, reklam verme ve servis özellikleri yatırımları gibi sekiz adet stratejik karar verdiği, internet tabanlı bir etkileşimli benzetim oyunu tasarlanmıştır. Rakip firma tarafının kararları, benzetim modelindeki karar kurallarınca alınmaktadır. Oyuncunun amacı; karlılık, gelir ve piyasa payı gibi performans ölçütlerini en üst seviyeye çıkarmaktır. Yapılan deneyler ve kapsamlı testler göstermektedir ki; interaktif oyun, gerçek hayattaki karar vericilerin, bir rakibe karşı oluşturdukları iş stratejilerini test etmeleri için uygun bir araç olmaya adaydır.

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# 1. INTRODUCTION

Pricing of a product is an important task for a company. In order to maintain a balance, companies have to carry out a pricing strategy such that while they are trying to increase their profits, they do not to lose customers due to rising prices. In a competitive market, pricing strategies of the firms affect directly the choices of the customers and indirectly the pricing strategies of the other firms in the market. As a result of these pricing decisions, companies may or may not sustain their business. Mitchell, Bridger & Vogelsang state that when the firms face competition they seek new pricing structures even without reference to economic and marketing theories [1].

Customers make their decisions somewhat rationally, although not optimally. In addition to the service/product prices, there are several other variables that affect customer preferences. For instance, quality of the service or advertisement could make a product more appealing. All of these elements contribute to the decision-making process of customers. This situation creates a difficult problem for the competing firms in determining their strategies.

Global System of Mobile Communications (GSM) market is a complex system; firms and customers and their numerous actions are the interacting components that make the system complex. Feedback mechanisms occur due to interactions between the elements of the system and most of these interactions are non-linear. For instance, a company cannot increase its number of customers always by increasing its advertising continuously. Threshold and saturation effects exist in such relationships. Furthermore, the system is dynamic because most elements are changing in time, they are not constant. All of these factors constitute the dynamic complexity of the system. In this context, analysis of the decision-making dynamics of the firms and the decisions of customers constitute an interesting topic for research.

# 2. PROBLEM DEFINITION AND RESEARCH OBJECTIVES

The problem of interest is to investigate ways to maximize the profit of a company and to increase its market share in an experimental way, using a dynamic simulation model. The company should determine the price level, advertising budget and spending on service features and quality to assure customer satisfaction. However, in a dynamic environment, the competitor firm gives responses to these actions and this can lead to complex dynamics.

It is stated that market shares of companies in a competitive environment are key factors for revenue and profit maximization. Firms may follow aggressive strategies to gain more customers and take the advantage of less average costs. However, these strategies, in the end, may result in serious problems for the market itself [2]. In common practice, firms usually offer lower prices to the prospective customers to recruit them from competitor operators, and charge relatively higher prices to their internal customers. Application of this pricing strategy effectively punishes the loyal customers and creates a pressure on them to churn out. Frequent churning of customers generate additional financial burden on companies in terms of marketing, pricing and service expenditures. Furthermore, if the competing companies in the market decide to follow the pricing strategies of each other, then, a price war between companies occurs and this situation may lead to a market collapse (*death spiral*) due to increasing costs and decreasing revenues in the long term.

Risk attitude of the companies is the main determinant in the creation of such a *death spiral*. In general, firms with lower market share are risk takers and they offer lower prices to increase their number of customers. On the other hand, market leaders try to avoid a price war and focus on customer retention with the help of investment in service quality and features, because a price war would have a larger impact on them. In order to sustain their businesses, firms should determine a price level that allows them to cover their expenses and to keep their customers satisfied at the same time. Thus, different company attitudes in determining the price and investment decisions can yield very different dynamics in companys' market share and profits, and even global market dynamics.

Finding the optimal policies in such complex dynamic feedback settings is mathematically impossible. So our objective is to build an interactive simulation model on which near optimal decisions can be searched experimentally. In order to analyze the dynamics of the above system, a dynamic simulation model and interactive simulation game are built to allow people to test different decision-making policies. The game version can be used as a *learning laboratory* in the interested companies, which can also be a first step toward *organizational learning* [3].

Web-based simulation games are suitable and widely used tools for testing management strategies and revealing unexpected or undesired behaviors. In a typical simulation game, players make strategic and operational decisions each simulated time period, and receive feedback from their past decisions [4]. It is stated that, in the example of *Beer Game*, even if the decision making task is straightforward, the interaction of individual decisions in a multi-agent environment may provide aggregate dynamics which diverge significantly from the optimal behavior [5]. In an another well-known example, *The Fish Banks Ltd. Game*, players make periodic managerial decisions and are expected to maintain a profitable business of fishing in bay area with the presence of several competitors [6]. The game shows that with poor competitive fishing strategies, companies drive the fish population down to extinction -the worst result for all parties involved.

Dynamic pricing methodology is mostly used in micro-economic studies in literature. It is stated that most of the economic models are developed and optimized by using static pricing strategies and these models do not include effects of the pricing competition in real life [7]. Dynamic systems simulation approach has some advantages over classical game theoretical analyses because game theory models suffer from several weaknesses which have limited their impact on strategy practice. One weakness is that game-theoretic models typically incorporate only a small number of variables in order to remain analytically tractable, and therefore fail to capture the simultaneous choices over many variables that characterize competition in most industries. The models also assume many variables to be constant, again to maintain analytic tractability over the relevant time horizons. Finally, the rationality requirements and common knowledge assumptions imposed on the agents of the game are usually unrealistic [8].

A simulation model development for adequate representation of entire GSM industry is not possible or necessary. Therefore, only selected key variables will be included in the model to show the systemic behavior of the telecommunication market focused around the problem definition. The purpose of a system dynamics study (*understanding and improving the dynamics*) is very different from short-term prediction (forecasting) of future values of variables. The very purpose of system dynamics study requires that the model consist of causal relations, not mere statistical correlations [9]. The deriving causal factors of demand to GSM service products are suggested as price, product and service quality, advertising and brand recognition [10].

A causal loop diagram for the main variables in competition in mobile communication market is suggested in Figure 2.1. As seen in the figure, main decision variables for two competing companies are price and investment. Through these decisions, the number of customers are affected, and cost, revenue and profit are generated. There are 5 balancing (negative) and 3 reinforcing (positive) main feedback loops in the diagram. Balancing loops are stable, they seek equilibrium in isolation. Reinforcing loops are unstable, they produce indefinite growth or collapse in isolation. The corresponding model dynamics will be determined according to the dominance of these loops, and that is why the model can generate different behaviors in different scenarios.

B1, B2, B3 and B4 are obvious loops that are responsible for balancing of the number of customers. If price goes up companies lose customer and decrease the prices. The same logic is valid for the investment. In B5, it is defined that more investment

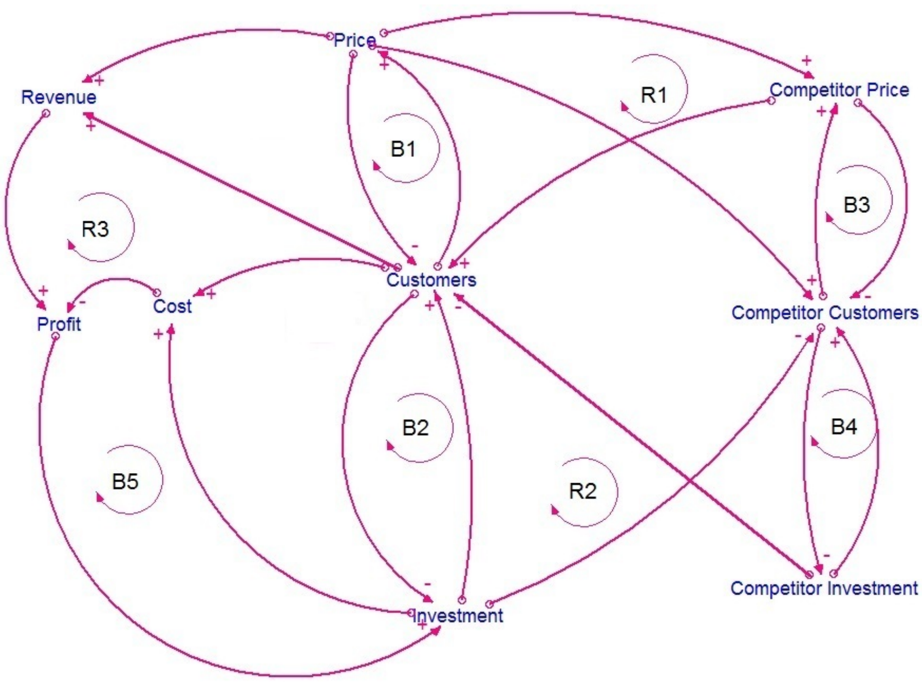



Figure 2.1. A Broad Causal Loop Diagram for the Problem

leads to more cost and less profit, in the end a decrease in investment.

R1 is describing pricing viscous cycles between competitors. If a company increases (decreases) its prices, the competitor also increases (decreases) and first company gains more (less) customers and finally more (less) customers cause a price increase (decrease). R2 is about investment relations. If the company increases its investment, the competitor loses customers and increases its investment, then the company loses customers and increases its investment further. R3 suggests that, if the number of customers increases, generated revenue and profit increase, more profit leads to more investment and finally the number of customers increases.

As the qualitative causal diagram and brief explanations above suggest, the purpose of the research is to build a quantitative dynamic model that represents the interactions between the actions of two competitors and customers in mobile communications market. The model is expected to help us analyze under what conditions what type of market dynamics will emerge. Finally, the simulation model will be converted into an interactive game whereby players can assume the role of a high level manager of a company and make key decisions periodically during a game session. The purpose of the player will be to maximize some performance measures like profits, revenues and market share. Players can thus experiment with the simulation game to gain accelerated experience about the management problem involved. The ultimate goal would be to offer a tool for real-life decision makers to test their business strategies against a competitor.

# 3. MODEL DESCRIPTION

Following the system dynamics methodology, the tentative variables are first defined and the causal links, and causal-loop diagram are obtained (Figure 2.1). Then the *stock* and *flow* variables are identified. Stocks represent the main accumulations in the system (such as customers or cumulative profit) and flows are the rates of changes of the stocks (such as new customers recruited per month or revenues per month). After the stock-flow diagram is complete (such as in Figure 3.1), the equations for all variables are written and parameters are estimated. The model is next tested and validated to ensure that it is an adequate representation of the problem of interest.

The model simulates an oligopolistic competition in a mobile communication market, in which two major companies, a player and a competitor, try to increase their profits and market share in terms of number of customers and generated revenues. The third component is called *market other* which represents all the other firms in market and they are not affected from or respond to directly to the other two major firms. In other words, *market other* always behaves normal regardless of the market structure, however the two major companies (the player and the computer) give responses to the actions of each other. In the model, companies have two fundamental decision factors that affect the dynamics of the market structure, namely prices and investment amounts (Figure 2.1).

Customers make decisions according to the price offers from companies and advertisement, service quality and service features levels that they perceive. Customer segments of the companies are divided into two by payment method preferences. These are *prepaid* and *postpaid* segments. It is assumed that younger people tend to choose prepaid method initially and as they grow they switch to postpaid segment, and this phenomena creates a natural flow from prepaid to postpaid sections. Quite minor opposite flow from postpaid segment to prepaid segment that is exists in real life, is ignored in the simulation model. The other possible flows of customers are between competitors, in which customers are affected mainly from varying price offers between competitors, advertisement level of competing company and service quality and features level of the company they are currently using. For simplicity, it is assumed that customers cannot switch their payment method at the same time they are changing their operator company. The two possible ways to switch are first switching to postpaid segment and then porting out to the other operator, or vice versa.

The model is designed to be an interactive simulation game in which the player decides price and investment levels for one company and in response to that, the other company's decision variables are made by the model, using decision heuristics. The decision structure is mainly based on competitor's prices and investments, market share and profitability. Time unit of the model is a month and the horizon for the simulation is selected as 120 months (i.e. 10 years) in order to observe the long-term market dynamics. The detailed construction of the model segments and variable formulations are explained below.

## 3.1. Prepaid Segment

Prepaid segment consists of 5 customer stocks (Figure 3.1). When the customers are acquired they stay for one year in an initial stock called *New Pre Paid*. After 12 months they advance in a decision state in which they can choose other alternatives. They can stay, port out to the competitor or port out to *market other*. Another option is to change the payment type by switching to the post-paid segment, which is a flow called "Pre to Post". The same situation exists for the competitor also and all stocks, flows and relations are symmetric.

There are 3 ways for acquisition of a customer: The first one is acquiring from no other company, which represents the new prepaid users. The second way is by porting in from the competitor, which means transferring customers from the competitor. And the final way of acquisition is porting in from *market other*. All these customers start as a new customer and stay for one year in the initial stock. Details of these flows and

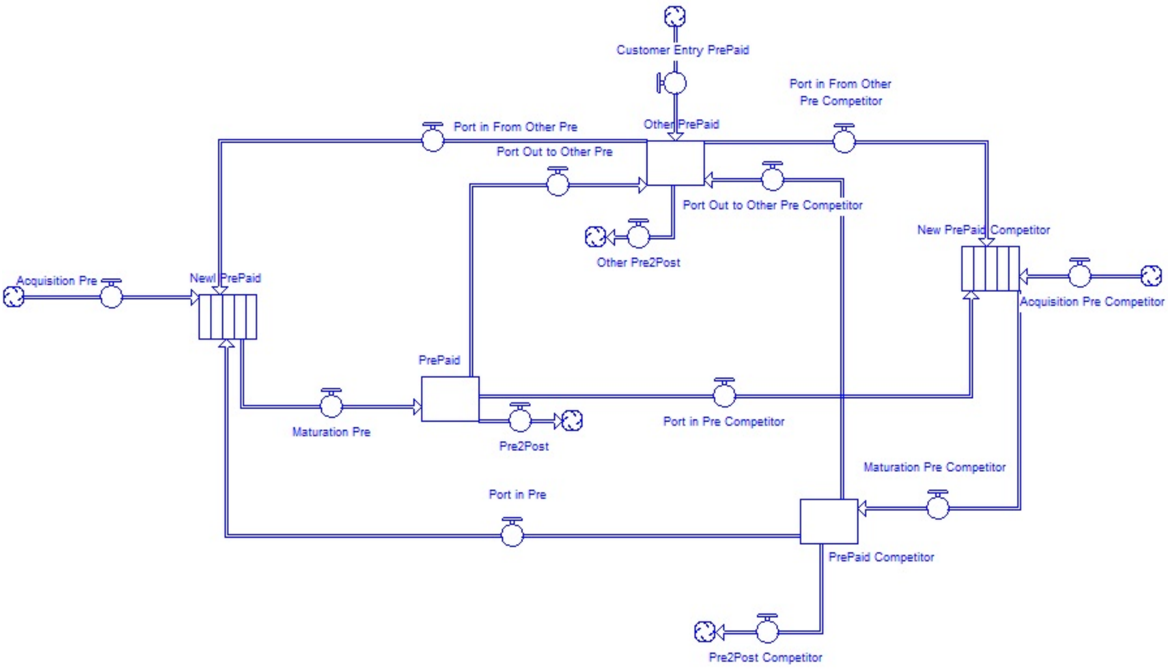



Figure 3.1. Prepaid Segment Customer Stocks and Flows

effecting factors are shown below in Figure 3.2.

### 3.1.1. Customer Inflow Formulations

There are three inflows of customers in prepaid segment: *Acquisition Pre*, *Port in Pre* and *Port in from Other Pre*.

$$\begin{aligned} Acquisition\ Pre = {} & Normal\ Acquisition\ Rate\ Pre * Price\ Effect\ on\ Acquisition\ Pre \\ & * \ Advertisement\ Effect\ on\ Acquisition\ Pre \end{aligned} \tag{3.1}$$

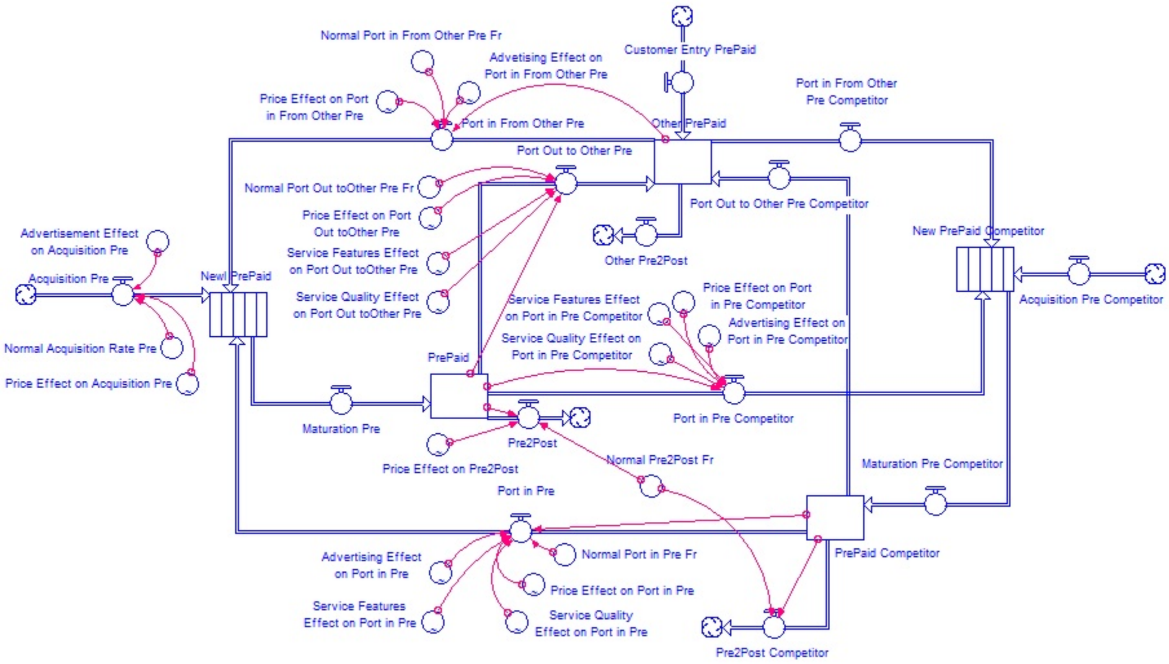



Figure 3.2. Prepaid Segment Flow Determinants

It is assumed that there is a normal new acquisition flow and it is affected by the price offered and the level of advertisement spending. If the company sets the normal values for the price and advertisement, then normal acquisition rate applies.

The value of the price effect is determined by the ratio of acquisition price by the normal price (Figure 3.3). If the company offers relatively higher price than the normal price, the price effect and the acquisition rate decreases. The limit for price increase is the double of the normal price because it is not possible to acquire any customers when the value of the flow goes to zero. If the company keeps the price level lower than the normal, then the value of the effect and the acquisition rate increase. The limit for the price effect is determined as 3, thus the acquisition rate may be tripled at max, if the price is extremely small, other things being equal.

The value of the advertisement effect on acquisition is determined by the ratio of advertising spending to the normal advertising spending (Figure 3.4). It is proportional to the level of advertising. Perceived advertising spending is a function of

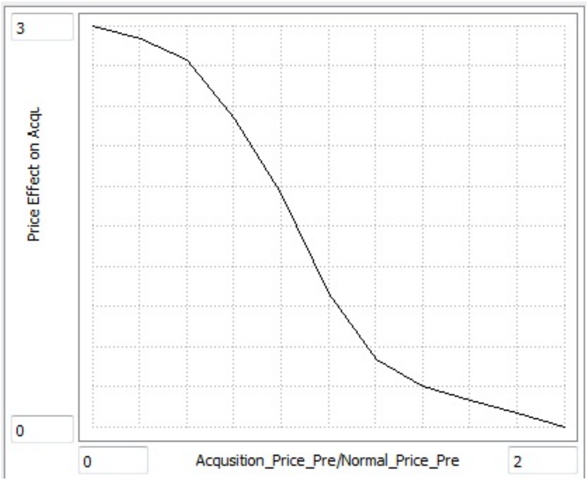



Figure 3.3. Price Effect on Acquisition Flow in Prepaid Segment

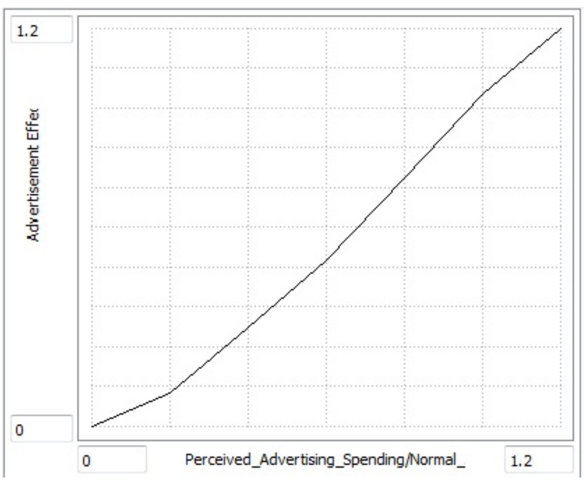



Figure 3.4. Advertising Effect on Acquisition Flow in Prepaid Segment

desired advertising spending. Detailed calculation of perceived advertising spending is explained in decision variables section.

$$
\begin{aligned}
Port\ in\ Pre\ =\ & PrePaid\ Competitor\ *\ Normal\ Port\ in\ Pre\ Fr \\
&*\ Price\ Effect\ on\ Port\ in\ Pre\ *\ Service\ Features\ Effect\ on\ Port\ in\ Pre \\
&*\ Service\ Quality\ Effect\ on\ Port\ in\ Pre\ *\ Advertising\ Effect\ on\ Port\ in\ Pre
\end{aligned}
\tag{3.2}
$$

In the above formulation, it is assumed that the company transfers a normal fraction of the competitor's prepaid customers. The price level of both companies, service features and service quality of the competitor affect this natural flow.

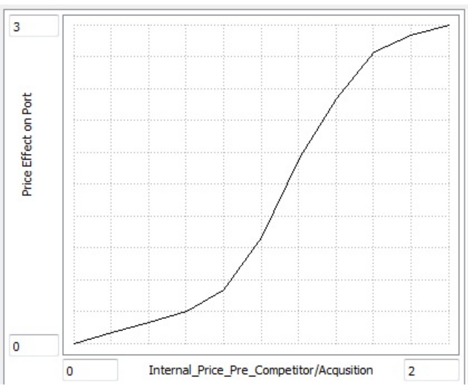



Figure 3.5. Price Effect on *Port in* Flow in Prepaid Segment

The value of price effect is determined by the ratio of competitor's prepaid price for matured customers, called *internal price pre*, divided by acquisition prepaid price of the company (Figure 3.5). Price comparison behavior of the customers is reflected in this formulation. If the competitor offers a relatively higher price, the price effect and the transfer flow become stronger and the competitor loses its customers rapidly.

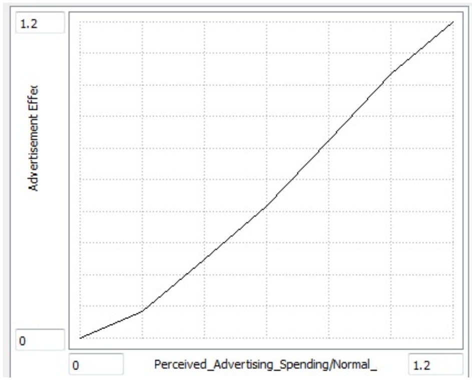



Figure 3.6. Advertising Effect on *Port in* Flow in Prepaid Segment

The value of advertising effect is determined by the ratio of perceived advertising spending divided by normal advertising spending (Figure 3.6). Attraction effect of advertising on customers' company choices is reflected in this effect formulation. If the perceived advertising level increases, tendency of the competitor customers to change operator company increases, and the flow becomes stronger.

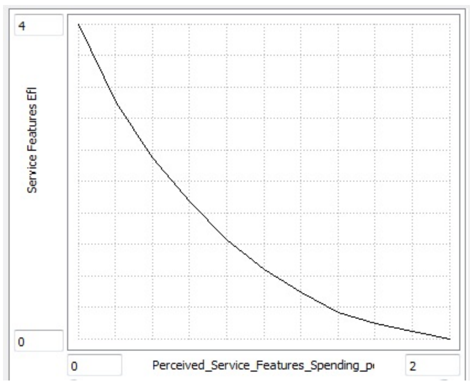



Figure 3.7. Service Features Effect on *Port in* Flow in Prepaid Segment

The value of service features effect is determined by the ratio of the perceived service features spending of the competitor divided by the normal service features spending (Figure 3.7). If the competitor spends more than normal, then its customers stay more satisfied and have less tendency to leave.

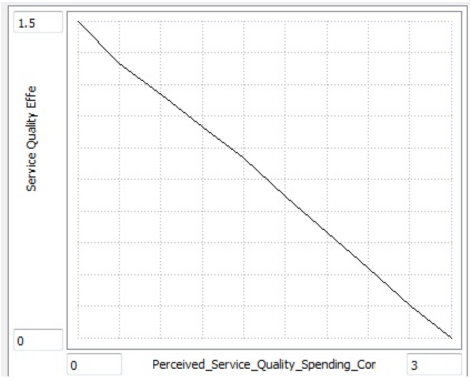



Figure 3.8. Service Quality Effect on *Port in* Flow in Prepaid Segment

Similar to the service features, *service quality effect on port in pre* is determined by the ratio of perceived service quality spending divided by the normal service quality spending (Figure 3.8). It is observed that prepaid segment customers are more sensitive to the service features than the service quality. More detailed difference between service features and quality is going to be explained in decision variables section.

$$\begin{aligned} Port\,in\,from\,Other\,Pre \;=\; & Other\,PrePaid * Normal\,Port\,in\,From\,Other\,Pre\,Fr \\ & *\;Price\;Effect\;on\;Port\;in\;From\;Other\;Pre \\ & *\;Advertising\;Effect\;on\;Port\;in\;From\;Other\;Pre \end{aligned} \tag{3.3}$$

In the above formulation, it is assumed that the company transfers a normal fraction of *market other's* prepaid customers. This formulation is similar to the *port in pre* formulation, but, since *market other* always behaves normally, the only effective variables are the acquisition price and the advertising spending of the company. Another difference is that, compared to *normal port in pre fraction*, *normal port in* *from other pre fraction* is less significant. Since the model is built to represent the competition between two main companies, normal rates of inflows from and outflows to *market other* are kept very low.

### 3.1.2. Customer Outflow Formulations

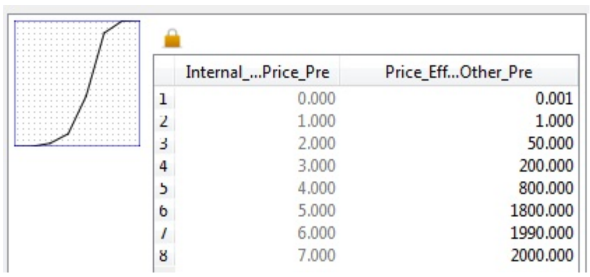
When customers are acquired, they stay for one year in *New Prepaid* stock, after this waiting time they proceed to the decision state, in which they can transfer to another company, stay or switch to the postpaid segment. Three representative outflows are described for this behavior. These flows are *Port in Pre Competitor*, *Port Out to Other Pre* and *Pre2Post*.

$$\begin{gathered} Port\ in\ Pre\ Competitor\ =\ PrePaid\ *\ Price\ Effect\ on\ Port\ in\ Pre\ Competitor \\ *\ Normal\ Port\ in\ Pre\ Fr\ *\ Advertising\ Effect\ on\ Port\ in\ Pre\ Competitor \\ *\ Service\ Features\ Effect\ on\ Port\ in\ Pre\ Competitor \\ *\ Service\ Quality\ Effect\ on\ Port\ in\ Pre\ Competitor \end{gathered} \tag{3.4}$$

$$\begin{gathered} Port\ Out\ to\ Other\ Pre\ =\ PrePaid\ *\ Normal\ Port\ Out\ to\ Other\ Pre\ Fr \\ *\ Price\ Effect\ on\ Port\ Out\ to\ Other\ Pre \\ *\ Service\ Features\ Effect\ on\ Port\ Out\ to\ Other\ Pre \\ *\ Service\ Quality\ Effect\ on\ Port\ Out\ to\ Other\ Pre \end{gathered} \tag{3.5}$$

*Port in Pre Competitor* flow is described as the symmetric counterpart of *Port in Pre* flow. It assumes natural outflow from *Prepaid* stock to *New Prepaid Competitor* stock which is affected by the price ratio of the competing companies, advertising level of the competitor, and service feature and quality investments.

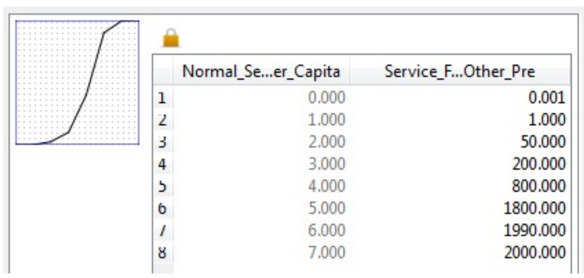
*Port out to Other Pre* flow is created to describe the insignificant outflow to *market other*. However, the insignificance is valid under normal circumstances. If the company sets a significantly higher price than the normal price or decides to invest in service features or quality significantly lower than normal, then the flow becomes stronger. As a result, the company may lose its customers to *market other* rapidly.



| | Internal_...Price_Pre | Price_Eff...Other_Pre |
|---|---|---|
| 1 | 0.000 | 0.001 |
| 2 | 1.000 | 1.000 |
| 3 | 2.000 | 50.000 |
| 4 | 3.000 | 200.000 |
| 5 | 4.000 | 800.000 |
| 6 | 5.000 | 1800.000 |
| 7 | 6.000 | 1990.000 |
| 8 | 7.000 | 2000.000 |

Figure 3.9. Price Effect on *Port out to Other* Flow in Prepaid Segment

Figure 3.9 explains how the price effect becomes stronger while the ratio of *internal price pre* divided by *normal price pre* increases.



| | Normal_Se...er_Capita | Service_F...Other_Pre |
|---|---|---|
| 1 | 0.000 | 0.001 |
| 2 | 1.000 | 1.000 |
| 3 | 2.000 | 50.000 |
| 4 | 3.000 | 200.000 |
| 5 | 4.000 | 800.000 |
| 6 | 5.000 | 1800.000 |
| 7 | 6.000 | 1990.000 |
| 8 | 7.000 | 2000.000 |

Figure 3.10. Service Features Effect on *Port out to Other* Flow in Prepaid Segment

The same formulation is used in the service features and service quality effects on *Port out to Other* flow (Figure 3.10).

$$Pre\ 2\ Post\ =\ Pre\ Paid * Normal\ Pre\ 2\ Post\ Fr * Price\ Effect\ on\ Pre\ 2\ Post \tag{3.6}$$

The final outflow formulation is switching from prepaid segment to postpaid segment (Figure 3.11). This flow assumes that a normal fraction of prepaid segment customers chooses to join postpaid segment and since this flow is inside the same company, it is affected not by investment decisions, but by the price offer difference of the two segments.

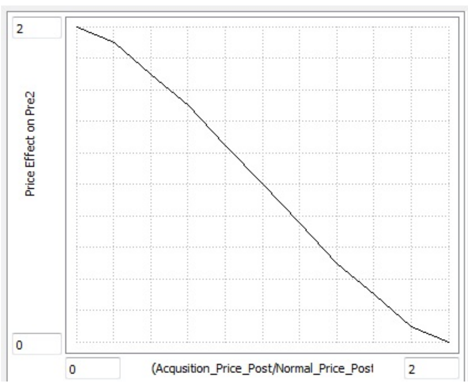



Figure 3.11. Price Effect on Prepaid to Postpaid Segment Flow

If the internal price for prepaid segment customers is relatively higher than the normal prepaid price or acquisition price for postpaid is relatively smaller than the normal postpaid price (or both) the effect becomes stronger and the switching process accelerates.

### 3.2. Postpaid Segment

Postpaid segment is the alternative segment to prepaid segment. As explained in the beginning of the model description chapter, switching process is a one way option. In other words, it is only realistic/possible to transfer from prepaid to postpaid segment. The other entering possibility is acquisition of new customers from non-user population. Although there are some differences from the prepaid segment, the main structure and cause and effect relations are common. Figure 3.12 shows the general structure.

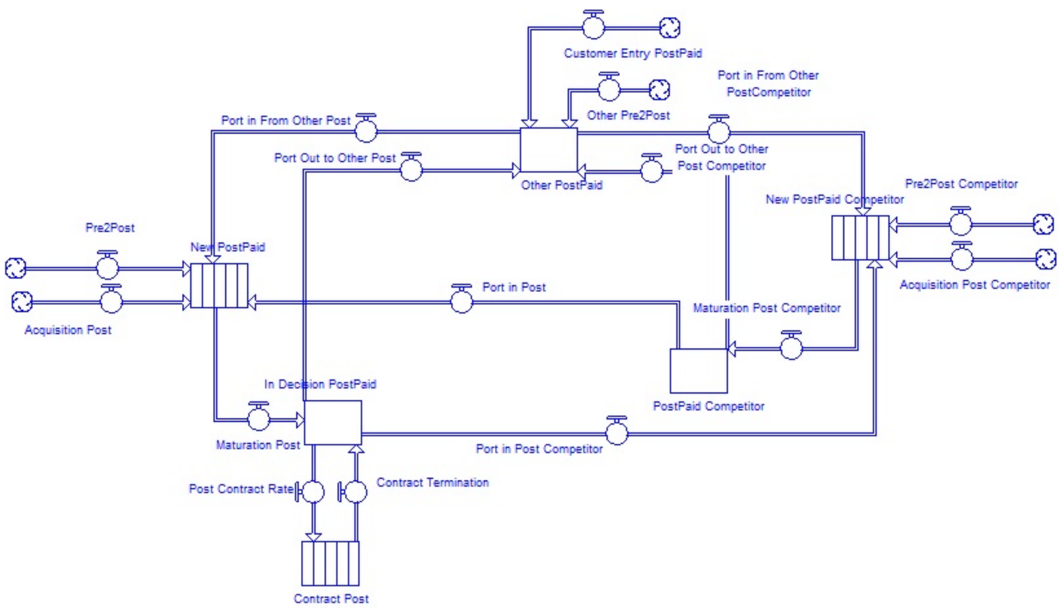



Figure 3.12. Postpaid Segment Customer Stocks and Flows

The first difference is *Pre2Post* outflows from prepaid segment are inflows to *New Postpaid* customer stocks. Secondly, in the model it is assumed that postpaid segment has an older population on the average. Thus, customers in this segment are less price sensitive, but more quality sensitive. Price effects have relatively less impact than service features and quality effects in postpaid segment due to this assumption. Details of these flows and effecting factors are shown below in Figure 3.13.

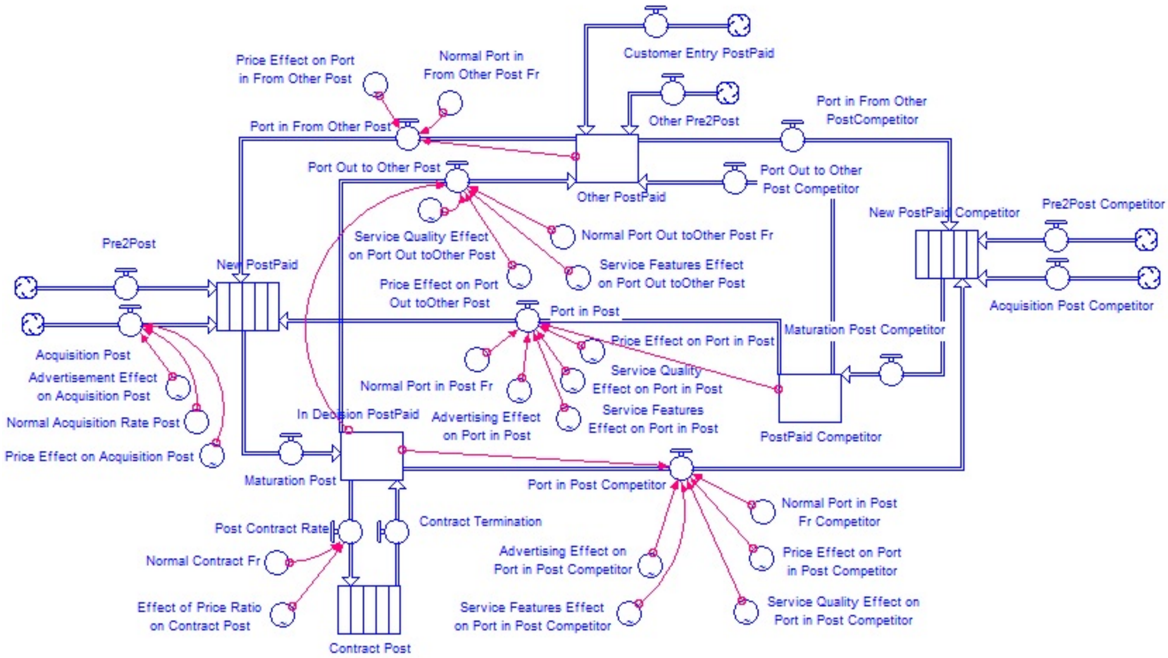


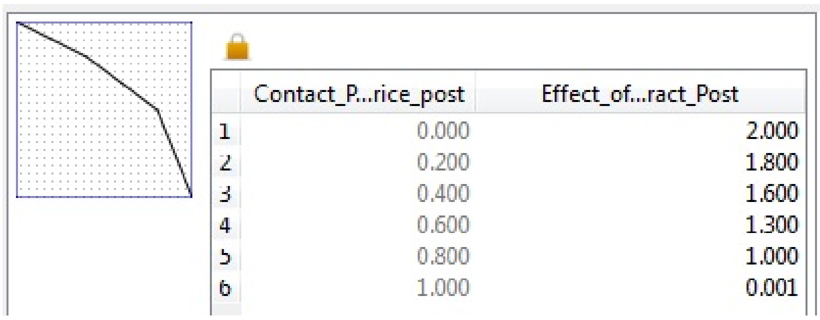

Figure 3.13. Postpaid Segment Flow Determinants

### 3.2.1. Postpaid Contract Structure

The last and the most significant difference between prepaid and postpaid segments is that there is a contract option for postpaid customers. If the company offers a relatively lower than the normal price for its matured postpaid segment customers, they may choose to stay in this contract state for another year. During this period these customers pay a constant agreed price called *Contract Price*. This stock, however, is not available for the competitor in the model because it is built from the perspective of one company and the contract status information is classified for the competitor. The decision maker only relies on the combined number of all postpaid customers of the competitor. Details of the difference between contract price and other price is going to be explained in the decision variables section.

$$Post\ Contract\ Rate = In\ Decision\ PostPaid * Normal\ Contract\ Fr * Effect\ of\ Price\ Ratio\ on\ Contract\ Post \quad (3.7)$$

The above formulation assumes that a natural fraction of customers of *In Decision Postpaid* stock chooses to have a contract. The only effect on contract rate is the ratio of contract and *internal postpaid price* offers.



| | Contact_P...rice_post | Effect_of...ract_Post |
|---|---|---|
| 1 | 0.000 | 2.000 |
| 2 | 0.200 | 1.800 |
| 3 | 0.400 | 1.600 |
| 4 | 0.600 | 1.300 |
| 5 | 0.800 | 1.000 |
| 6 | 1.000 | 0.001 |

Figure 3.14. Price Effect on Contract Rate in Postpaid Segment

It is a fact that if a customer is offered with the same price for a contract and no-contract, he or she would not take the offer because the contract requires one year of commitment. Hence if the price ratio is equal to 1 then the multiplication effect and the contract rate becomes 0 (Figure 3.14). The suggested normal price ratio is set to 0.8 in the model. If a relatively lower contract price is offered to the customers, they have more tendency to take it.

### 3.3. Decision Variables

Companies make two general types of decision in the market. These are pricing and investment decisions. Customer flows are shaped by the influence of these decisions.

### 3.3.1. Prices

Companies make price offers according to customer segments, prepaid and postpaid, and membership. For instance, there may be a price difference for their own customers and competitor's customers. In order to transfer from the competitor or to acquire new market adopters they offer *Acquisition Price*. For their own customers, they offer *Internal Price*. In general, acquisition prices are relatively lower than internal prices. The logic behind this phenomenon is that it is generally hard for a customer to switch operators for the same price. In the postpaid segment of the model only, contract price is also available. As explained in the postpaid segment section, it allows the company to hold some of its matured customer for another year. All the prices in the model represent monthly fees.

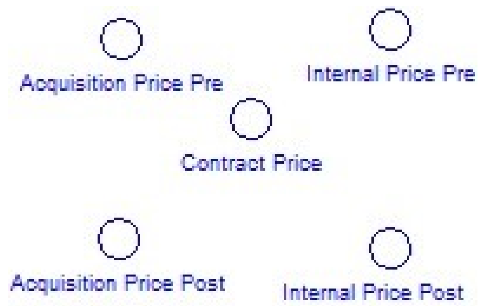



Figure 3.15. Price Types

Acquisition prices and contract price are effective at the exact time that customers enter corresponding stocks (*New Prepaid*, *New Postpaid* and *Postpaid Contract*). If the prices are changed in the next month, they only affect new coming customers, not the ones entered in past months. On the other hand, internal prices are effective for only one month. Remaining customers in corresponding stocks (*Prepaid* and *Postpaid In Decision*) are charged with monthly changing prices.

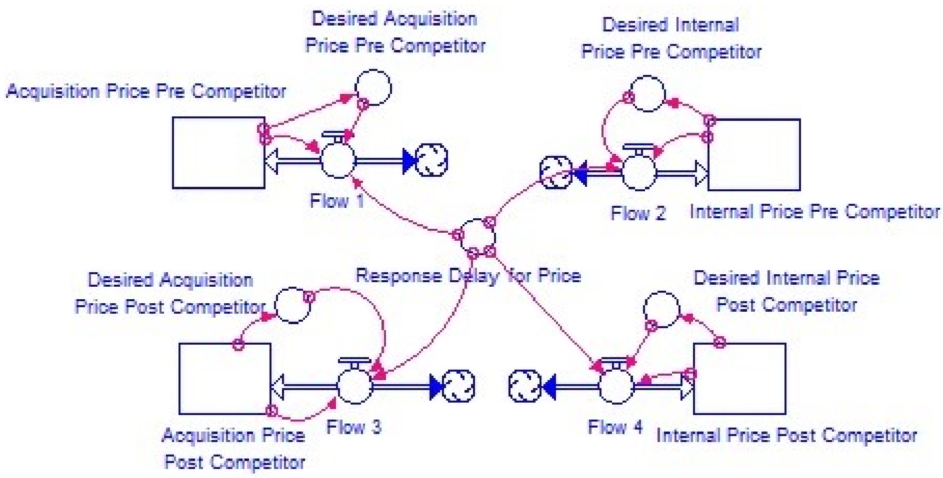



Figure 3.16. Pricing Structure of the Competitor Company

$$Rate\ of\ Change\ of\ Acquisition\ Price\ Pre\ Competitor\ = \\ (Desired\ Acquisition\ Price\ Pre\ Competitor\ -\ Acquisition\ Price\ Pre\ Competitor) \\ /\ Response\ Delay\ for\ Price \tag{3.8}$$

Competitor's prices are designed as model-generated response actions to the player's decisions and are based on the market dynamics. Desired levels of the prices are determined immediately, but, the actual prices are calculated after a response time delay. A *first order information delay* structure with constant response delay is used to model this behavior of the competitor (Figure 3.16). How the desired levels of the competitor's prices are calculated is going to be explained in the competitor response mechanism section.

### 3.3.2. Investments

There are three types of investment decisions in the model, namely *advertising spending*, *service features spending* and *service quality spending*. Another variable called *capital expenditure (CAPEX)* is an automatic variable cost, but not a decision variable. Thus, it is going to be explained in the cost and revenue calculation section. All investment variables represent expenditures of the companies for a specific investment type in monthly terms.

Advertising spending is effective in attracting the new joiners to the market and the transfer of competitor's customers. It is considered the easiest and quickest way of available investment types, yet not as significant as other investment types in avoiding or leading to a major customer loss.

Investment on service features consists of expenditure of telecommunication companies on service enhancements such as consultancy expenses or research and development budget allocation. This type of investments generally returns in revenues in longer terms than the advertisement investment. Another difference is that, service features investment decision is made per customer. As mentioned before in customer flows section, service features spending is essential to keep the customers in the company. Lack of this investment would result in customer loss.

The final type of investment is spending on service quality. Base station infrastructure or broadband frequency license fees are classified as service quality investments in the model. This type of investments is for the longest term of returns compared to others. Like service features investment, inadequate level of service quality investment also causes customer loss. It is hard to foresee and recover from undesired market situation caused by lack of service quality investment.

Contrary to the price levels, investment spending levels are not perceived by the customers immediately. There is a significant time delay between actual spending on

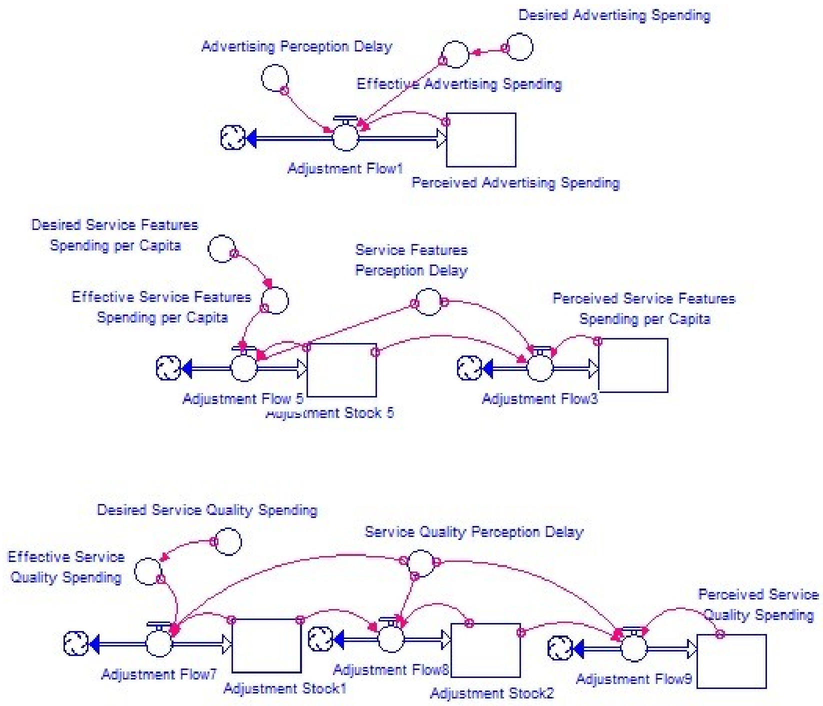



Figure 3.17. Investment Structures

an investment and its action on the customers' choices. Information delay structures are used to represent this behavior in the model. First, second and third order information delays are applied in advertising, service features and service quality investments respectively, in order to represent perception dynamics (Figure 3.17).

$$\begin{gathered} Effective\ Advertising\ Spending\ =\ IF\ Projected\ Desired\ Cost\ Competitor\ > \\ Projected\ Revenue\ Competitor\ *\ (1+\ Overspending\ Coefficent) \\ THEN\ (Projected\ Revenue\ Competitor\ *\ (1\ +\ Overspending\ Coefficent)) \\ *\ (Desired\ Advertising\ Spending\ Competitor\ /\ Projected\ Desired\ Cost\ Competitor) \\ ELSE\ Desired\ Advertising\ Spending\ Competitor \end{gathered} \tag{3.9}$$

There is a limitation on investment amounts. Companies decide their desired levels of investments, but they are not allowed to spend much higher amounts than their projected revenues. *Overspending coefficient* determines how large is going to be their budget deficit in the next month. Details of the *projected revenue* and *projected cost* are going to be explained in the cost and revenue calculation section.

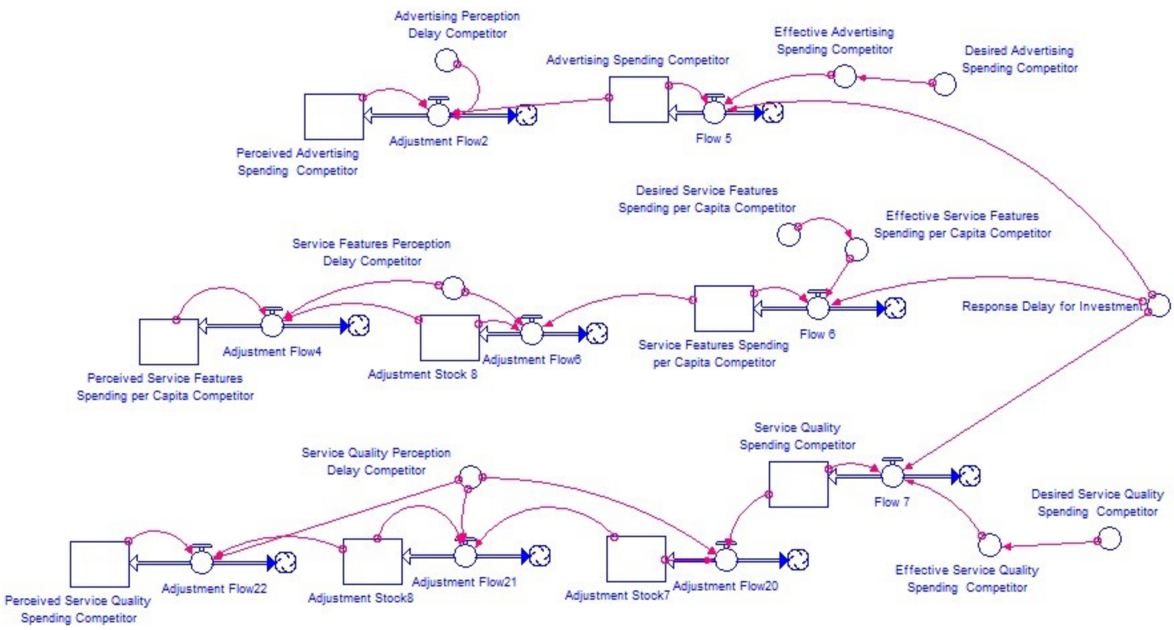



Figure 3.18. Investment Structure of the Competitor Company

Similar to the pricing formation, investments of the competitor are designed as model-generated response actions to the player's. *Desired* and *effective* levels of the investments are determined immediately, but the actual values are calculated after a response time (Figure 3.18).

A first order information delay structure with constant response delay is used to model this behavior of the competitor. After actual spending levels are calculated, again information delay structures exist in order to reflect perception dynamics of the customers. How desired levels of the competitor's investments are calculated is going to be explained in the competitor response mechanism section.

## 3.4. Cost and Revenue Calculation

Cost and revenue calculation is handled dynamically in the model. They are modeled as inflows to and outflows from profit stock. In general effective prices and number of customers determine the revenue and investments determine the cost. Figure 3.19 shows the general structure.

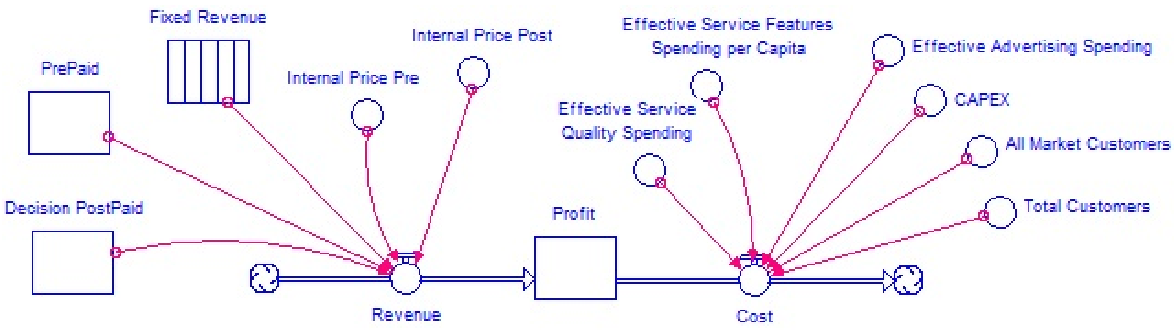



Figure 3.19. Cost and Revenue Structure

### 3.4.1. Cost

Cost is calculated as the sum of all monthly investment decisions and $CAPEX$ as an indirect item.

$$\begin{aligned} Cost \ = \ & Effective\ Advertising\ Spending + Effective\ Service\ Quality\ Spending \\ & + Total\ Customers * Effective\ Service\ Features\ Spending\ per\ Capita \\ & + CAPEX * (1 + Total\ Customers \ / \ All\ Market\ Customers) \end{aligned} \tag{3.10}$$

Since service features spending is decided per capita, the actual monthly cost for the company is calculated by multiplying it with the total number of customers of the company.

*CAPEX* cost is a variable cost dependent on market share. In addition to a fixed amount, a variable cost is calculated by dividing the number of customers of the company by the number of customers of the entire market.

### 3.4.2. Revenue

Monthly revenue also consists of fixed and variable parts. As mentioned in customer stocks section, matured customers pay monthly variable internal price every month (and decide whether or not to transfer to the competitor). The other part of the revenue is generated from the customers of *new prepaid*, *new postpaid* and *contract postpaid* stocks and they pay constant prices for one year.

$$\begin{aligned} Revenue &= Fixed\ Revenue + Prepaid * Internal\ Price\ Pre \\ &\quad + In\ Decision\ Postpaid * Internal\ Price\ Post \end{aligned} \tag{3.11}$$

In *fixed revenue* calculation, a *conveyor* structure is used (Figure 3.20). When customers enter the corresponding stocks, effective price which is fixed for one year, multiplied with the number of customers entering to the stock gives monthly revenues. And thanks to the conveyor structure this monthly revenue stays in the stock for one year and added to the main revenue flow each month as a fixed revenue item.

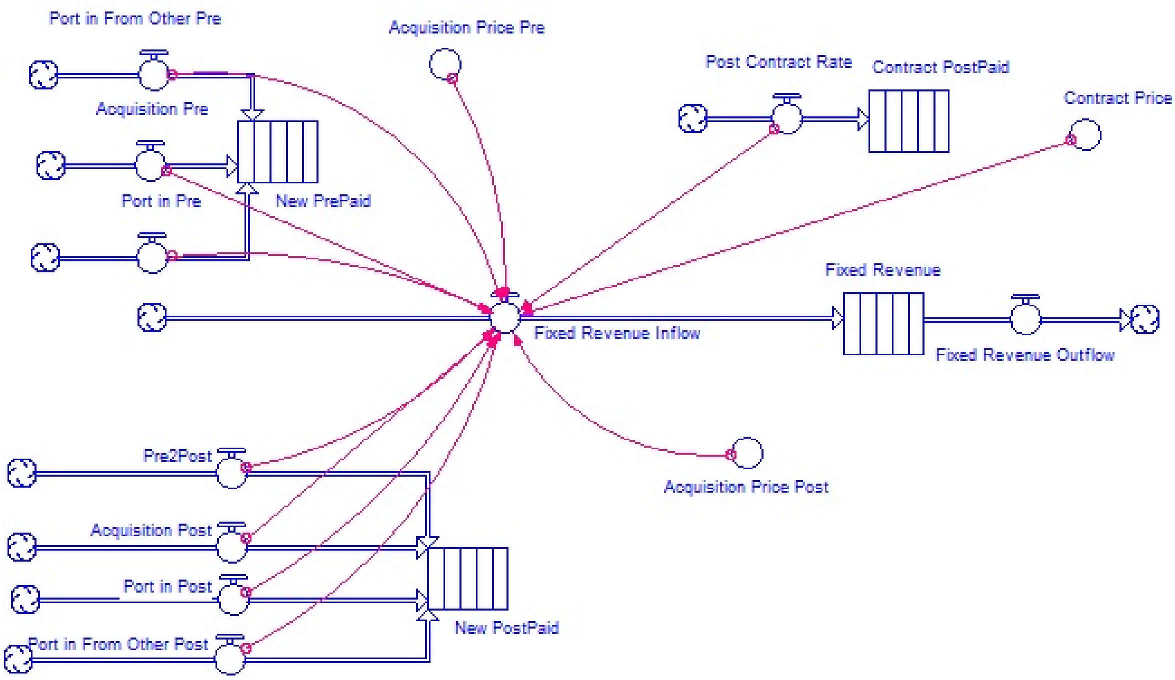



Figure 3.20. Fixed Revenue Structure

$$\begin{aligned} Fixed\ Revenue\ Inflow\ &= Contract\ Price * Post\ Contract\ Rate \\ &+ (Acquisition\ Pre + Port\ in\ Pre + Port\ in\ From\ Other\ Pre) \\ &* Acquisition\ Price\ Pre + Acquisition\ Price\ Post \\ &* (Acquisition\ Post + Port\ in\ Post + Post\ in\ From\ Other\ Post + Pre2Post) \end{aligned} \tag{3.12}$$

### 3.4.3. Projected Desired Cost and Revenue

*Projected desired cost* and *projected desired revenue* are calculated in order to foresee the financial situation of the next month. They are used to determine how much of the desired investment values will be spent effectively (Equation 3.9). As mentioned before in decision variable section, it is not allowed to spend more than the expected income. However it is not possible to calculate exact values because of the complex dynamic structure. It is assumed that the number of customers and effective prices will be stable during next term.

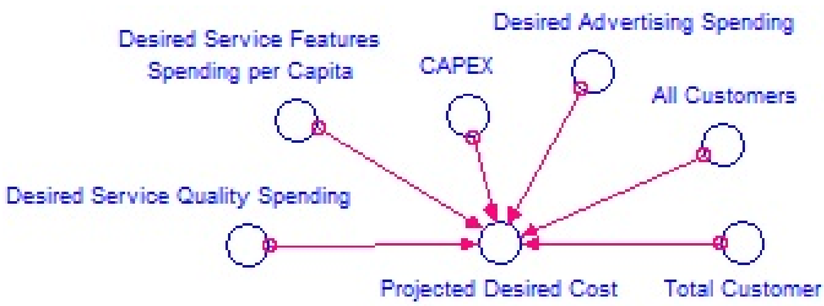



Figure 3.21. Projected Desired Cost Structure

$$\begin{aligned} Projected\ Desired\ Cost \ = \ & Desired\ Advertising\ Spending \\ & + \ Desired\ Service\ Quality\ Spending \ + \ Total\ Customers \\ & * \ Desired\ Service\ Features\ Spending\ per\ Capita \\ & + \ CAPEX \ * \ (1 \ + \ Total\ Customers \ / \ All\ Market\ Customers) \end{aligned} \tag{3.13}$$

$$\begin{aligned} Projected\ Revenue \ = \ & Acquisition\ Price\ Pre * New\ Prepaid + Internal\ Price\ Pre \\ & * \ Prepaid \ + \ Acquisition\ Price\ Post \ * \ New\ Postpaid \ + \ Internal\ Price\ Post \\ & * \ In\ Decision\ Postpaid \ + \ Contract\ Price \ * \ Contract\ Postpaid \end{aligned} \tag{3.14}$$

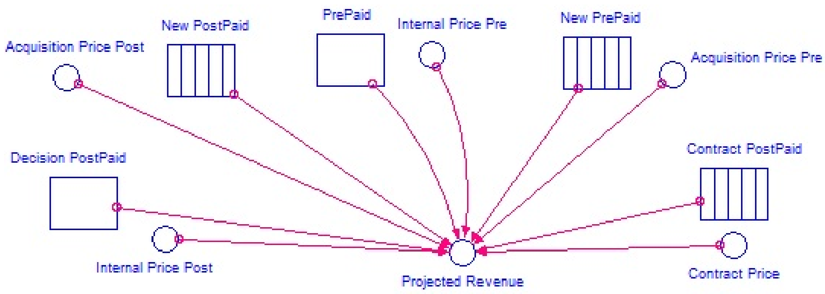



Figure 3.22. Projected Revenue Structure

## 3.5. Competitor Response Mechanism

In response to the price and investment actions, the competitor decides its own desired values of investment and price levels.

### 3.5.1. Desired Investment

Desired investment structure is the same in all investment types, advertising spending, service features and service quality. The structure for *desired service features spending* calculation is shown in Figure 3.23. It is calculated as multiplication of the normal value for the specific investment type with *investment multiplier*.

$$\begin{aligned} & Desired\ Service\ Features\ Spending\ per\ Capita\ Competitor \\ & \quad = Normal\ Service\ Features\ Spending\ per\ Capita\ *\ Investment\ Multiplier \end{aligned} \tag{3.15}$$

There are two components that affect investment multiplier. These are *market share effect* and *profit ratio effect*.

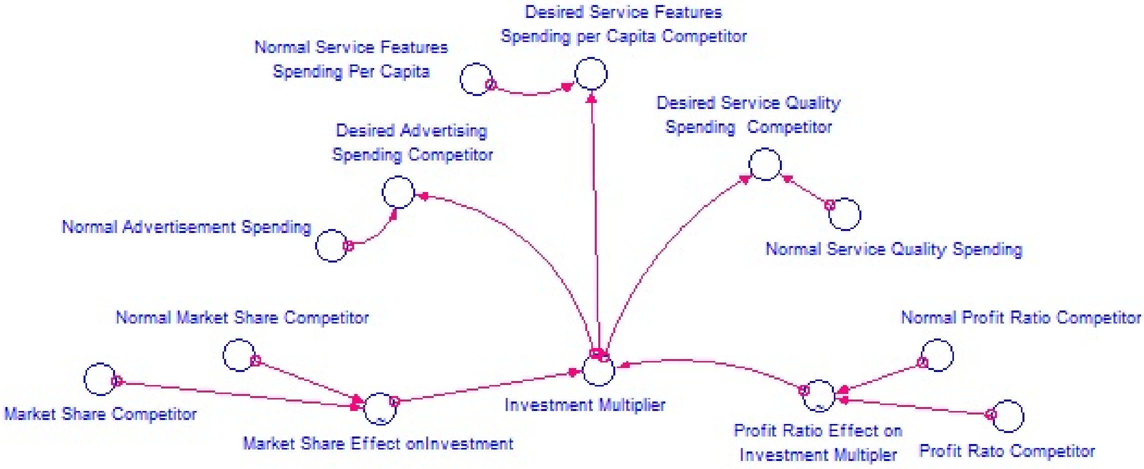



Figure 3.23. Desired Investment

$$Investment\ Multiplier = Market\ Share\ Effect\ on\ Investment$$
$$*\ Profit\ Ratio\ Effect\ on\ Investment\ Multiplier \tag{3.16}$$

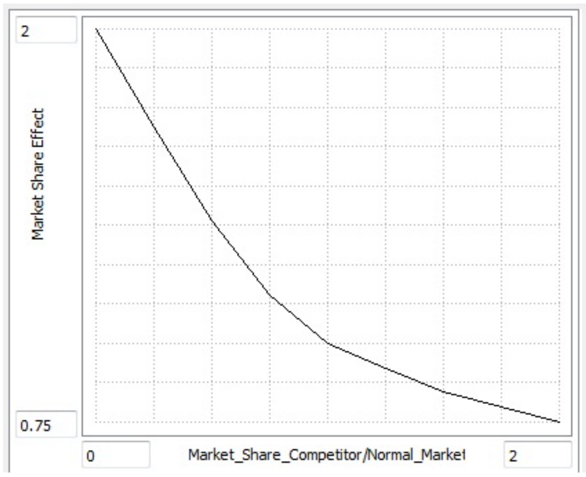



Figure 3.24. Market Share Effect on Investment Multiplier

*Market share effect* is determined by the ratio of competitor market share divided by *normal market share competitor* (Figure 3.24). If current market share of the competitor is below the normal market share, the effect becomes stronger and the competitor increases its investments, in order to attract more customers or not to lose the existing ones.

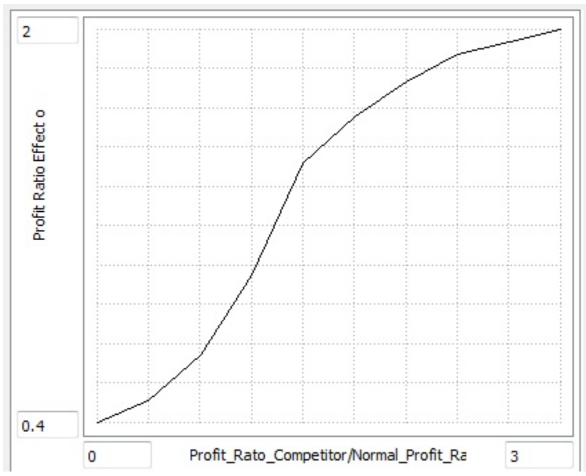



Figure 3.25. Profit Ratio Effect on Investment Multiplier

*Profit ratio* affects *investment multiplier* in increasing fashion. If the average revenue of the recent period is above the average cost, then the competitor increases its investments (Figure 3.25). Otherwise, since the competitor loses money, it would reduce the investment cost.

### 3.5.2. Profit Ratio Calculation

Profit ratio is calculated as *average revenue of the competitor* divided by *average cost competitor*. A first order information delay structure is used to calculate the average values of the recent periods (Figure 3.26).

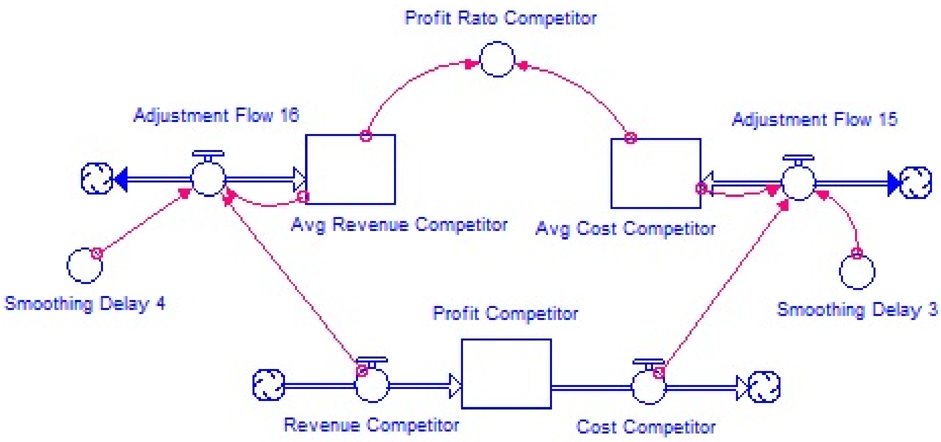



Figure 3.26. Profit Ratio Calculation

$$Rate\ of\ Change\ of\ Avg\ Cost\ Competitor$$
$$= (Cost\ Competitor - Avg\ Cost\ Competitor)\ /\ Smoothing\ Delay\ 3 \tag{3.17}$$

$$Rate\ of\ Change\ of\ Avg\ Revenue\ Competitor$$
$$= (Revenue\ Competitor - Avg\ Revenue\ Competitor)\ /\ Smoothing\ Delay\ 4 \tag{3.18}$$

### 3.5.3. Desired Price

Similar to desired investment, desired price is also determined by the multiplication of the normal price with calculated *price multiplier* in all types of price. However, since the price is effective immediately in the model, we must introduce some inertia in its dynamics to avoid unrealistic up and down movements. *Self dependency fraction* is used to include this inertia in desired price formation. The structure for calculation of desired price is shown in Figure 3.27.

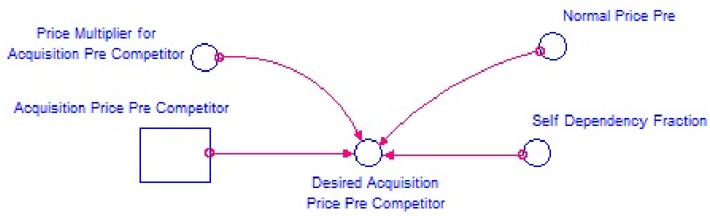



Figure 3.27. Desired Price

$$Desired\ Acquisition\ Price\ Pre\ Competitor = (1 - Self\ Dependency\ Fraction) * Normal\ Price\ Pre * Price\ Multiplier\ for\ Acquisition\ Pre\ Competitor + Self\ Dependency\ Fraction * Acquisition\ Price\ Pre\ Competitor \tag{3.19}$$

### 3.5.4. Price Multiplier Generation

*Price multiplier* is for each price type is calculated by the multiplication of *price effect* and *market share effect*.

Price effect for each type of price is determined by the ratio of average prices of the company and the competitor in the recent period (Figure 3.29). If the competitor has relatively higher price average, then, it tends to decrease and vice versa. This effect tries to keep the companies consistent in terms of price offers.

Market share effect is determined by the ratio of average number of customers of the companies (Figure 3.30). If the competitor has relatively fewer customers in the recent period, it decides to lower its prices to gain more customers.

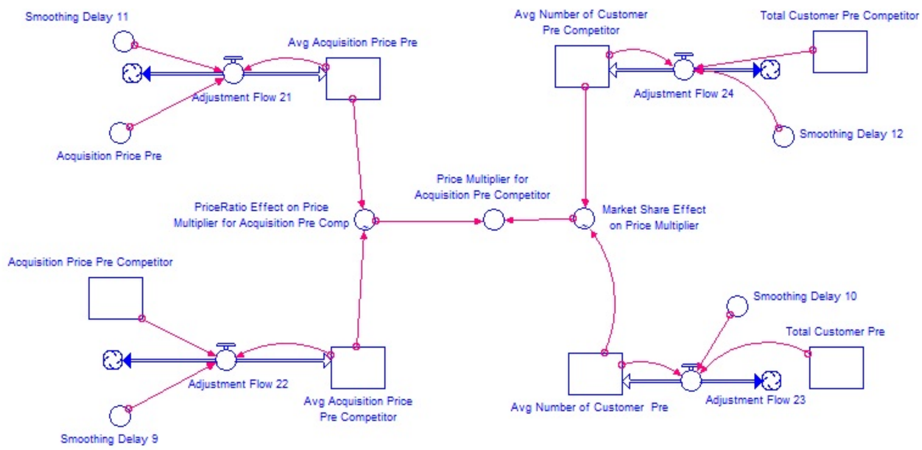



Figure 3.28. Price Multiplier Generation

$$\begin{aligned} &Price\ Multiplier\ for\ Acquisition\ Pre\ Competitor \\ &\quad = Price\ Ratio\ Effect\ on\ Price\ Multiplier\ for\ Acquisition\ Pre\ Competitor \\ &\qquad\qquad\qquad * Market\ Share\ Effect\ on\ Price\ Multiplier \end{aligned} \tag{3.20}$$

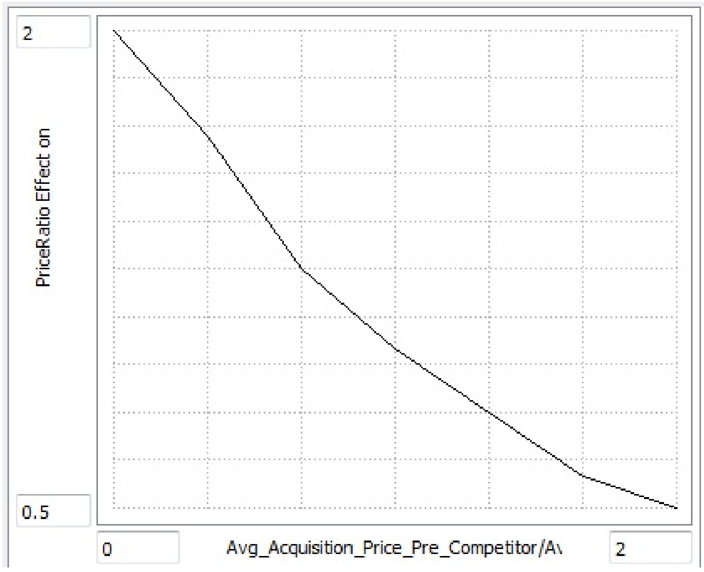



Figure 3.29. Price Ratio Effect on Price Multiplier

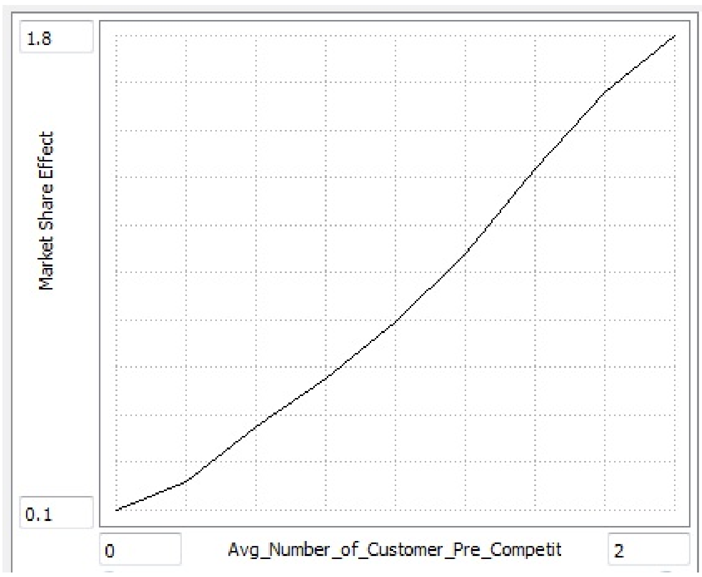



Figure 3.30. Market Share Effect on Price Multiplier

# 4. MODEL OUTPUT ANALYSIS

In this chapter base model outputs and the model behavior under extreme conditions are discussed to evaluate model validity.

## 4.1. Base Model Output

In the base scenario, the model is run with the normal values for the company, including all decisions at constant normal values, and the market dynamics are examined.

### 4.1.1. Base Model Price Outputs

In the base scenario, the company applies fixed normal price for the whole simulation, 40 TL per month for the prepaid segment, 60 TL per month for the postpaid segment and 48 TL per month for contract postpaid price. The competitor, as a response action, decreases its prepaid segment prices and increases postpaid segment prices gradually. See Figures 4.1, 4.2, 4.3 and 4.4 below.

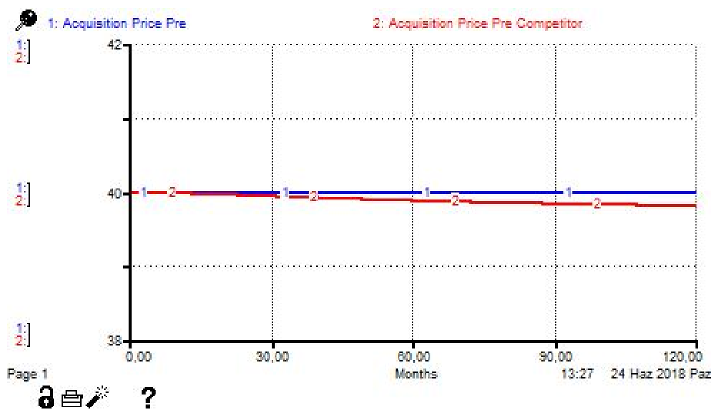



Figure 4.1. Base Model Output; Prepaid Acquisition Prices


Figure 4.2. Base Model Output; Prepaid Internal Prices

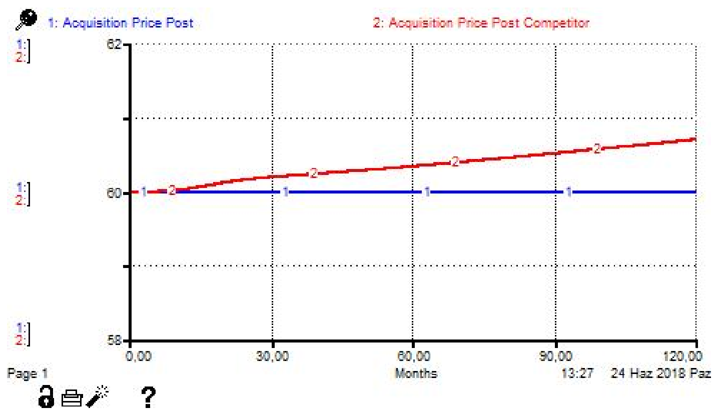



Figure 4.3. Base Model Output; Postpaid Acquisition Prices

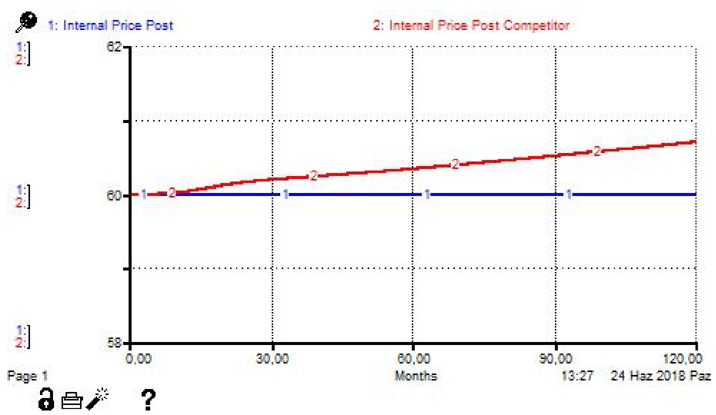



Figure 4.4. Base Model Output; Postpaid Internal Prices

### 4.1.2. Base Model Investment Outputs

In the base scenario, the company applies normal desired investment spending levels constantly for the whole simulation, 50M TL per month for the advertising, 30 TL per month per customer for the service features and 100M TL per month for the service quality. The competitor response action is first an overshoot above the normal level and then a constant increase in desired spending levels for all investment types. The reason behind this behavior is contract structure. Customers with a contract pay less than customers without a contract. Since the competitor has no customers with a contract, has a better profit ratio than the company in the beginning. And this leads a quick increase in investment multiplier. In addition to desired investments, perceived values of the desired investments are also proportional, which means that projected revenues are always above the projected costs in the simulation. See Figures 4.5, 4.6, 4.7, 4.8, 4.9 and 4.10 below.

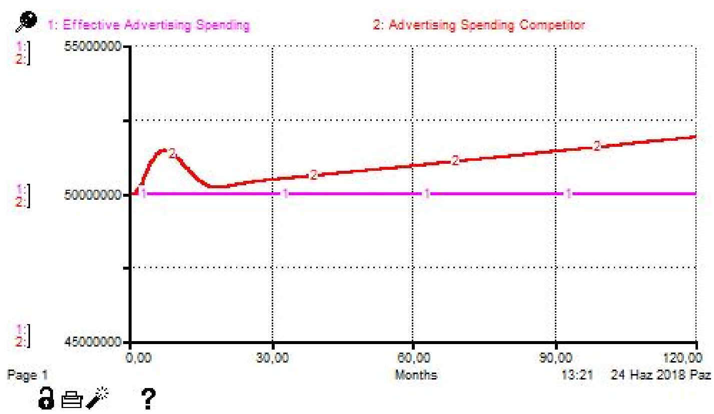



Figure 4.5. Base Model Output; Advertising Spending

### 4.1.3. Base Model Customer Stocks Outputs

In the base scenario, as a result of pricing and investment actions of the two companies, the competitor is better off. In prepaid segment, while the company loses customers, the competitor increases. On the other hand, in postpaid segment, both

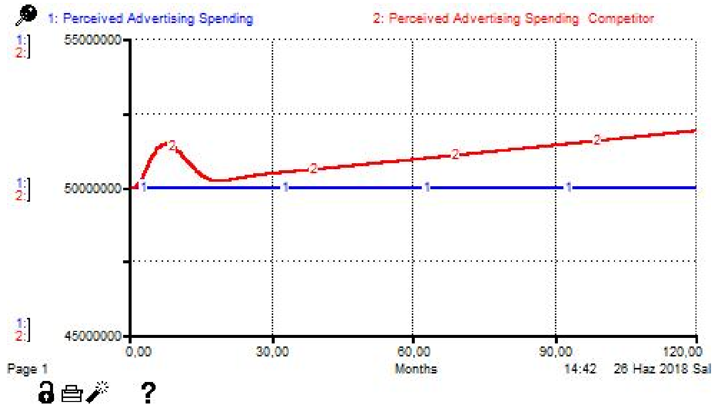



Figure 4.6. Base Model Output; Perceived Advertising Spending

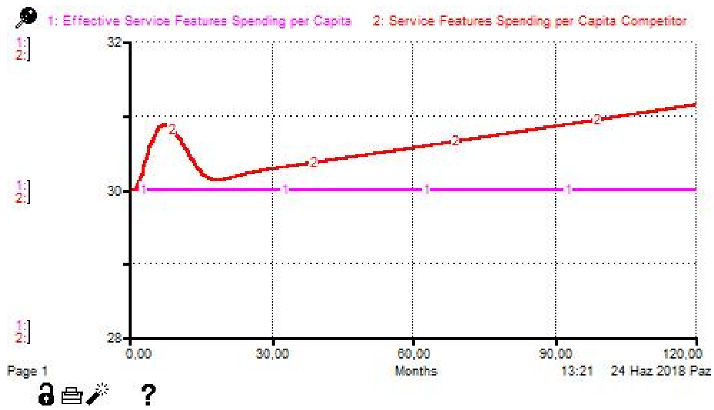



Figure 4.7. Base Model Output; Service Features Spending

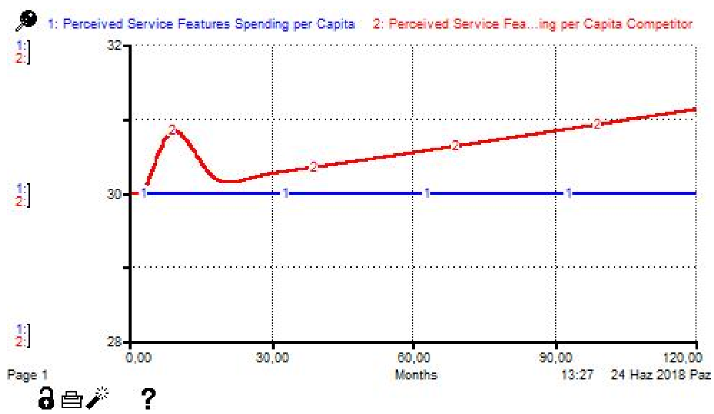



Figure 4.8. Base Model Output; Perceived Service Features Spending

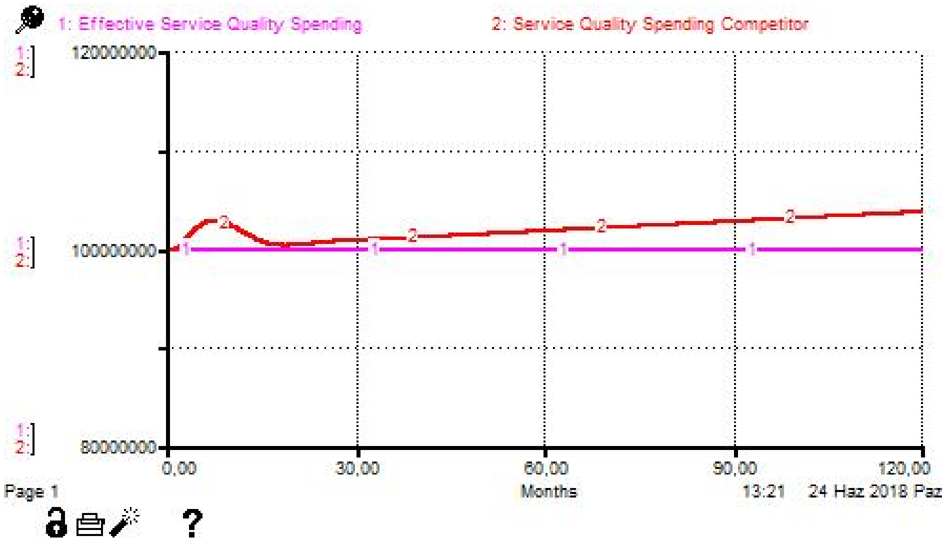



Figure 4.9. Base Model Output; Service Quality Spending

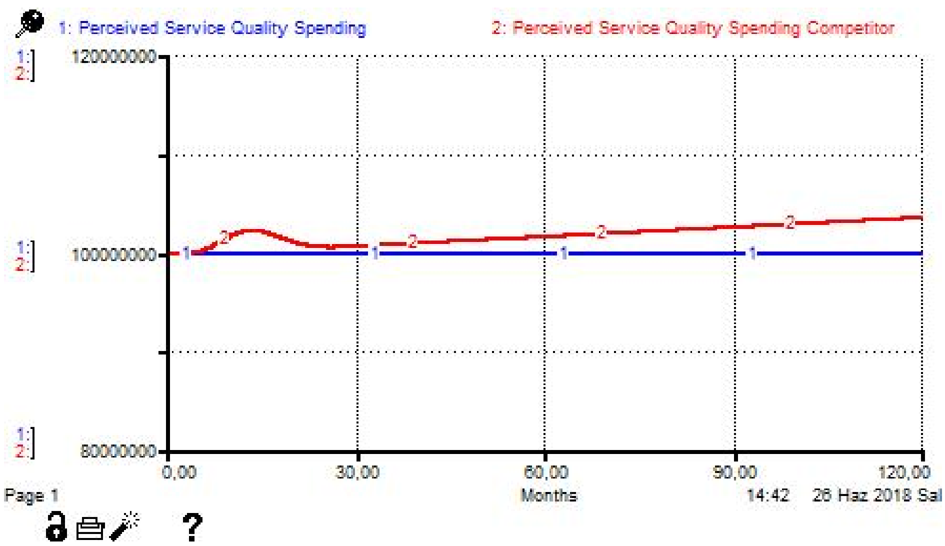



Figure 4.10. Base Model Output; Perceived Service Quality Spending

increase their number of customers, however the competitor increases faster. Thus, the competitor takes some portion of the company's total market share. *Market other* keeps its market share and grows with the same (assumed growth) rate as the total market. See Figures 4.11, 4.12, 4.13, 4.15 and 4.14 below.

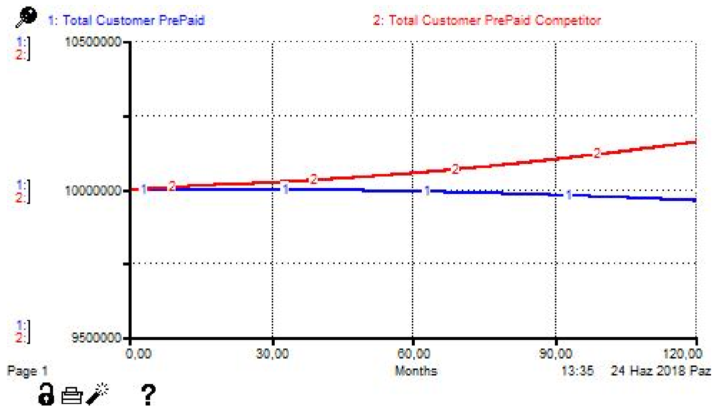



Figure 4.11. Base Model Output; Prepaid Customers

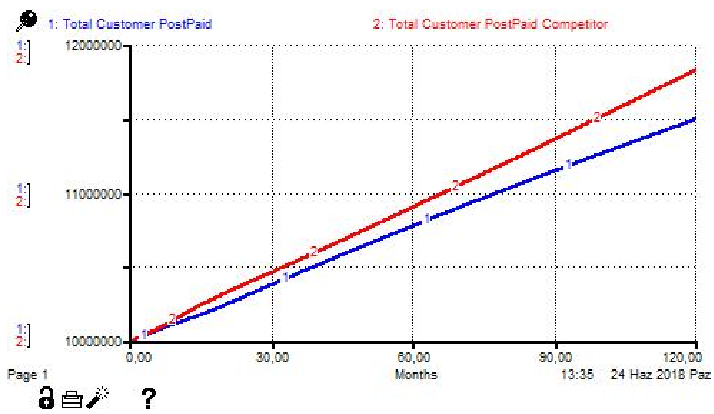



Figure 4.12. Base Model Output; Postpaid Customers

### 4.1.4. Base Model Revenue and Cost Outputs

In the base scenario, revenues and costs of both the company and the competitor behaves in similar fashion. However, like in the market share, the competitor is slightly better. Therefore, the competitor makes more profit at the end of the simulation run.


Figure 4.13. Base Model Output; Total Customers

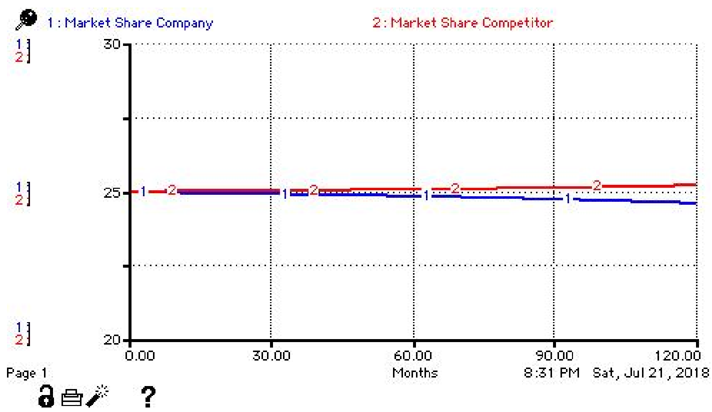



Figure 4.14. Base Model Output; Market Share

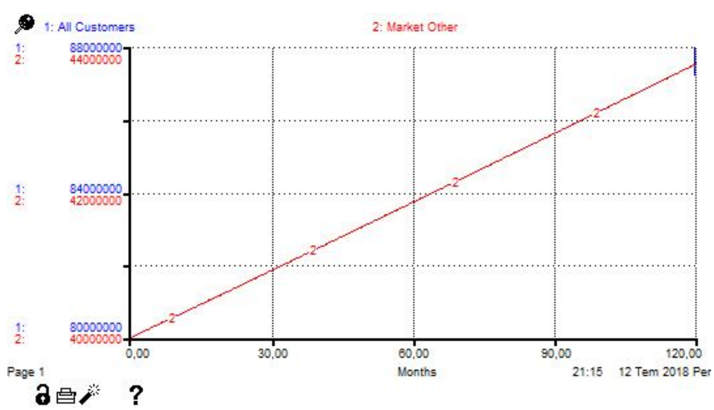



Figure 4.15. Base Model Output; Total Customers *Market Other*

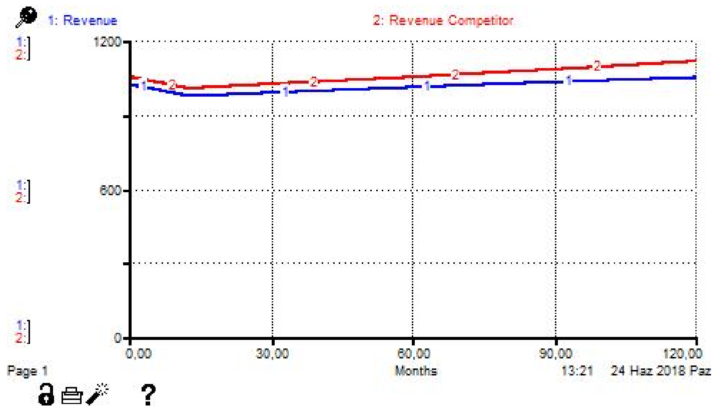



Figure 4.16. Base Model Output; Revenues

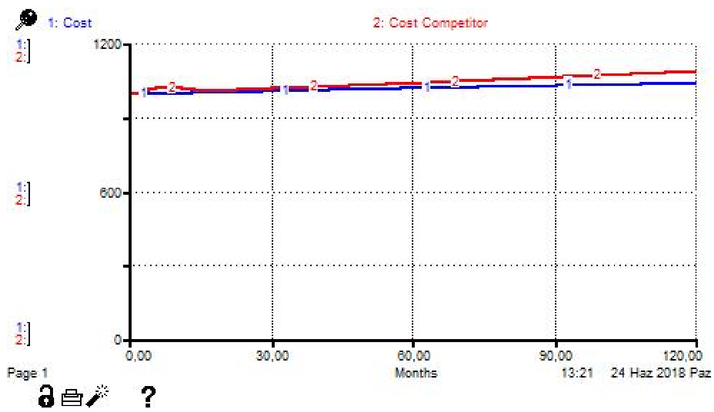



Figure 4.17. Base Model Output; Costs

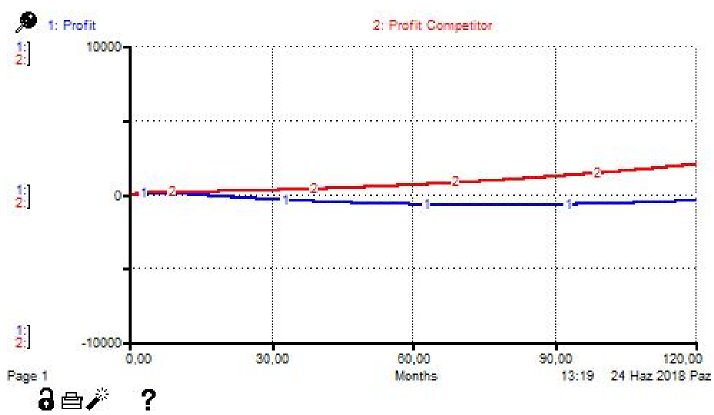



Figure 4.18. Base Model Output; Profits

Table 4.1. Base Values of Main Parameters and Initial Values of Main Variables

| | |
|---|---|
| *Acquisition Price Pre* | 40 TL per month |
| *Internal Price Pre* | 40 TL per month |
| *Acquisition Price Post* | 60 TL per month |
| *Internal Price Post* | 60 TL per month |
| *Contract Price Post* | 48 TL per month |
| *Advertising Spending* | 50M TL per month |
| *Service Features Spending per Capita* | 30 TL per month per capita |
| *Service Quality Spending* | 100M TL per month |
| *CAPEX* | 200M TL per month |
| *Response Delay for Investment* | 4 months |
| *Response Delay for Price* | 2 months |
| *Self Dependency Fraction of Price* | 0,75 |
| *Overspending Coefficient* | 3% |

## 4.2. Extreme Condition Tests

In this section, the model is tested under extreme conditions to evaluate its structural validity. The base values of main parameters and initial values of main variables are listed below in Table 4.1.

### 4.2.1. Company's Acquisition Price Extremely Low

In this case it is checked if the model behaves valid when the acquisition price is set at an extreme low value. *Acquisition price pre* is set to 1 TL per month and competitor price approaches from normal price (40 TL per month) to relatively lower price in the long run. On the other hand, *internal price* becomes higher through time in order to increase profits. Company loses money because of extreme low fee and the competitor increases its profits. Even with a very low acquisition price, the company cannot beat the competitor in terms of total customers, since it cannot do adequate investments with very low revenues.


Figure 4.19. Extremely Low Acquisition Price Case; Acquisition Prices

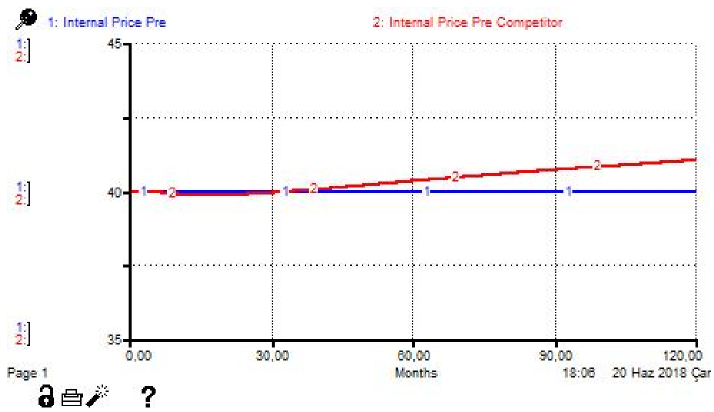



Figure 4.20. Extremely Low Acquisition Price Case; Internal Prices

### 4.2.2. Company's Acquisition Price Very High

In this case it is checked if the model behaves valid when the acquisition price is set at a very high value. *Acquisition price pre* is set to 200 TL per month and competitor price approaches from normal price (40 TL per month) to relatively higher price in the long run. *Internal price* becomes higher through time in order to increase

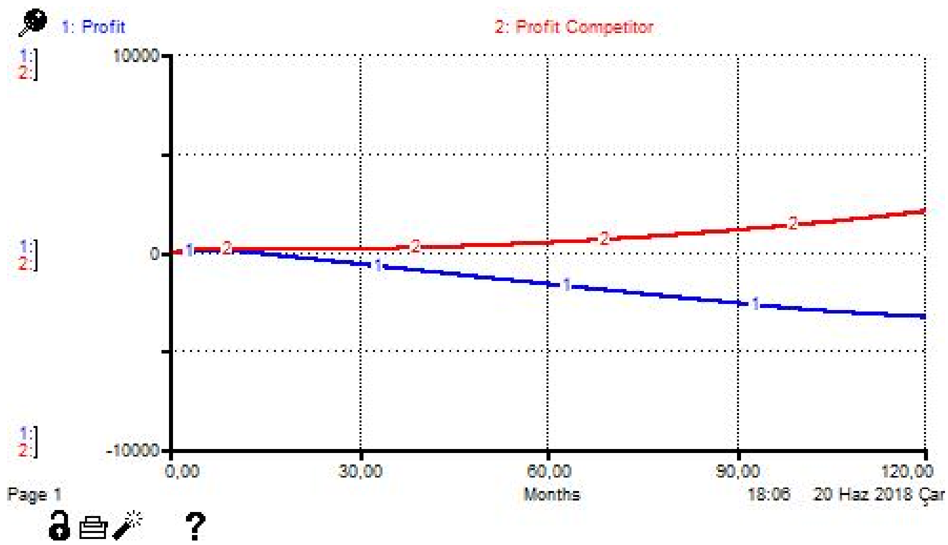



Figure 4.21. Extremely Low Acquisition Price Case; Profits

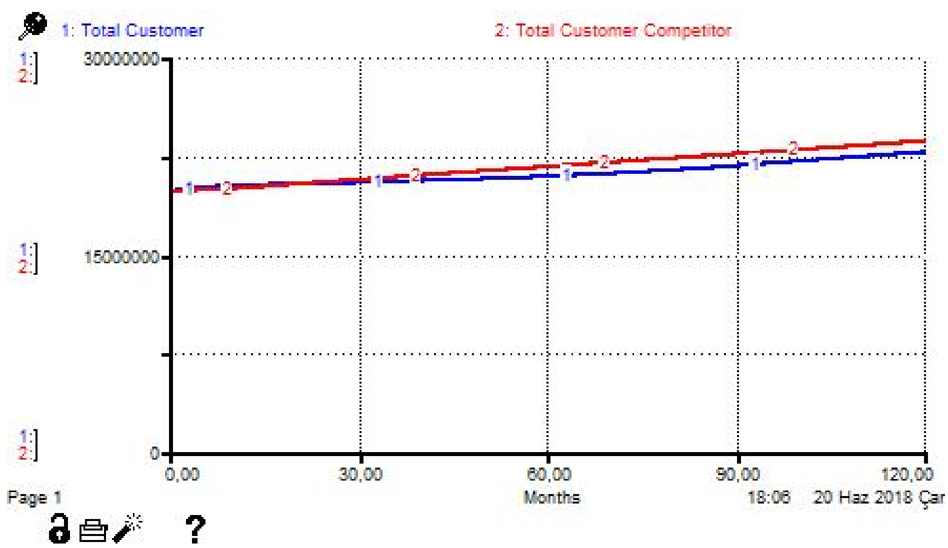



Figure 4.22. Extremely Low Acquisition Price Case; Total Customers

profits. Company loses (mostly from *New Prepaid* stock) customers due to extreme price and this results in a decrease in the profits.

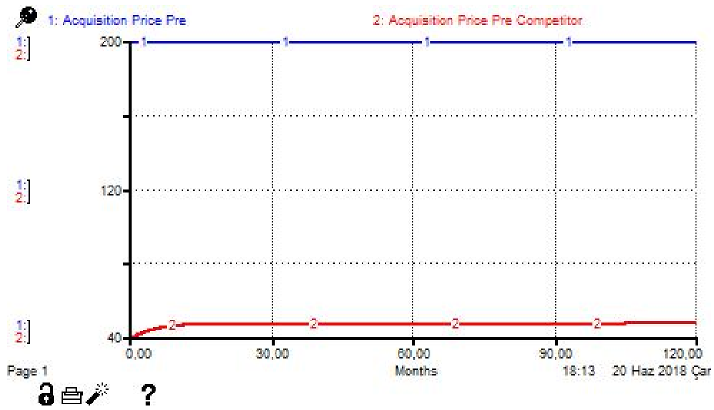



Figure 4.23. Very High Acquisition Price Case; Acquisition Prices

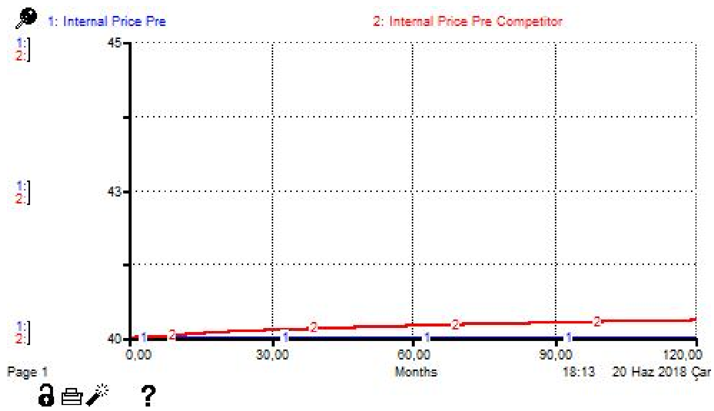



Figure 4.24. Very High Acquisition Price Case; Internal Prices

### 4.2.3. Company's Internal Price Extremely Low

In this case it is checked if the model behaves valid when *internal price* is set at an extreme low value. *Internal price pre* is set to 1 TL per month and competitor price approaches from normal price (40 TL per month) to relatively lower price in the long run. Due to lower prices revenues go down immediately. Since projected revenues are much lower than the projected desired costs, companies cannot spend enough on investments. Lack of investment leads to customer loss and decline in the profits.


Figure 4.25. Very High Acquisition Price Case; Total Customers

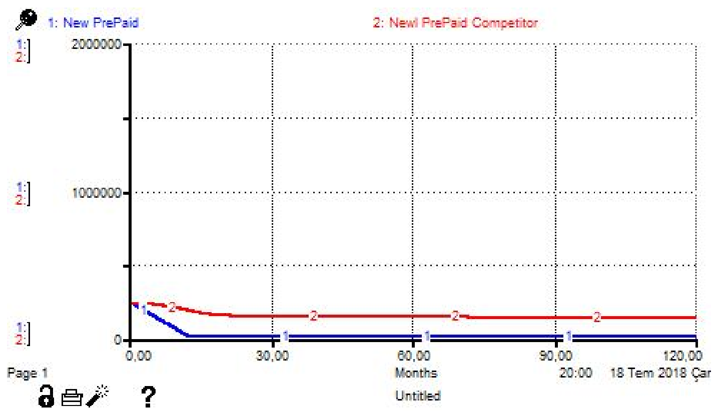



Figure 4.26. Very High Acquisition Price Case; New Prepaid Customers

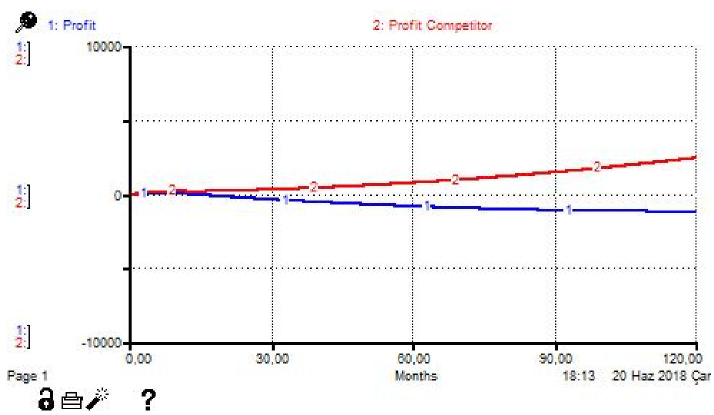



Figure 4.27. Very High Acquisition Price Case; Profits


Figure 4.28. Extremely Low Internal Price Case; Internal Prices

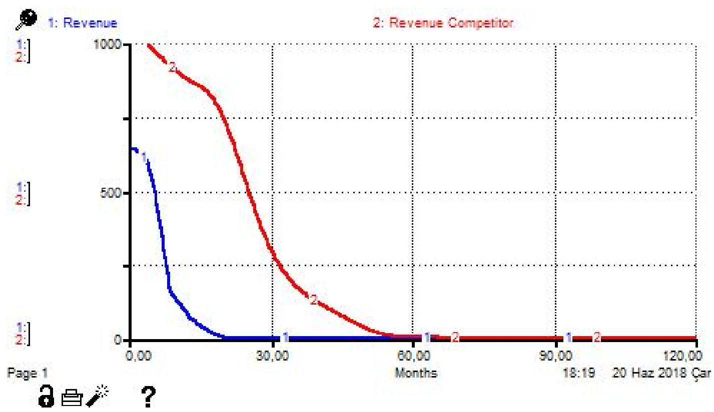



Figure 4.29. Extremely Low Internal Price Case; Revenues

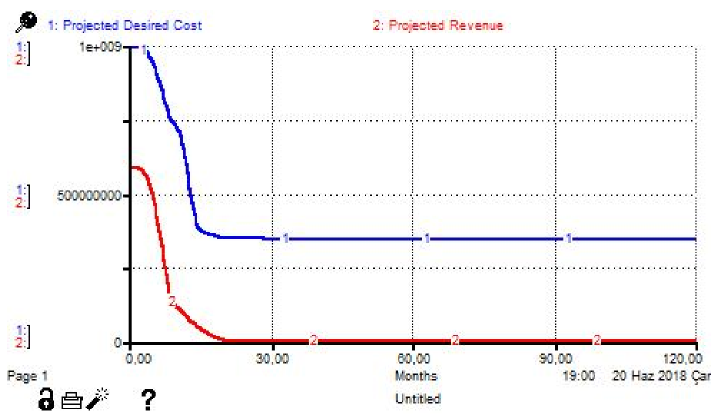



Figure 4.30. Extremely Low Internal Price Case; Projected Revenue and Desired Cost

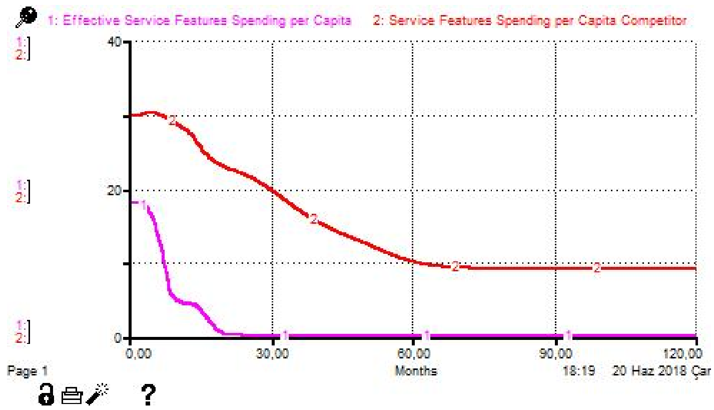



Figure 4.31. Extremely Low Internal Price Case; Service Feature Spending

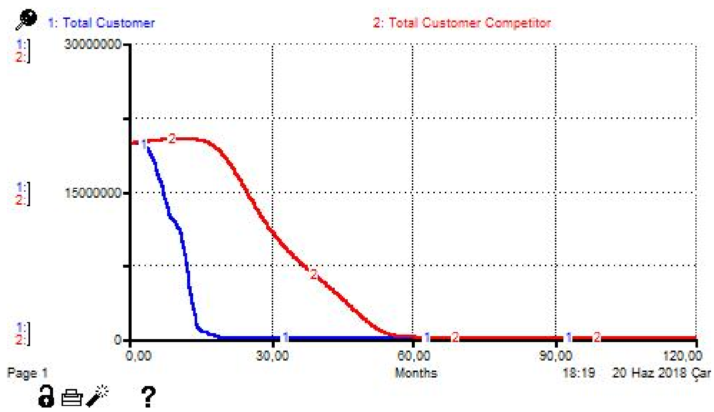



Figure 4.32. Extremely Low Internal Price Case; Total Customers

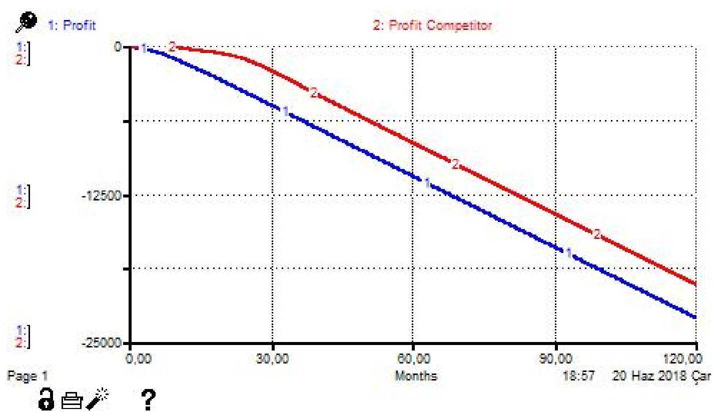



Figure 4.33. Extremely Low Internal Price Case; Profits

### 4.2.4. Company's Contract Price Very High

In this case it is checked if the model behaves valid when *contract price* is set at a very high value. Setting a very high contract price (200 TL per month) effectively eliminates contract option of the company. In this situation company keeps all of its postpaid segment customers in *In Decision Postpaid* stock and this leads to a higher rate of customer loss to the competitor.

Competitor gains more customers and generates more profit than the company through time. A positive feed-back loop behavior occurs, and the competitor increases its investment spending, and this leads to even more customer gain and profit generation.

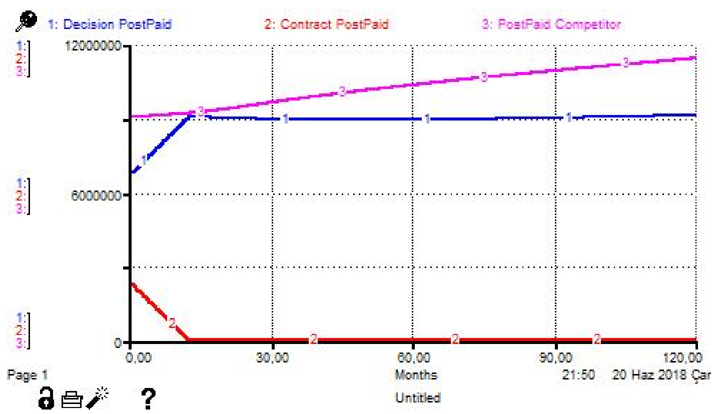



Figure 4.34. Very High Contract Price Case; Postpaid Segment Customers

### 4.2.5. Company's Advertising Spending Very Low

In this case it is checked if the model behaves valid when the advertising spending is set at a very low value (10M TL per month). Low level of advertising immediately affects customer gain, number of *new postpaid* customers drops rapidly. Total number of customers and the profit of the company decreases gradually. Due to low profit level the company could not afford even that low level of investment spending. When the

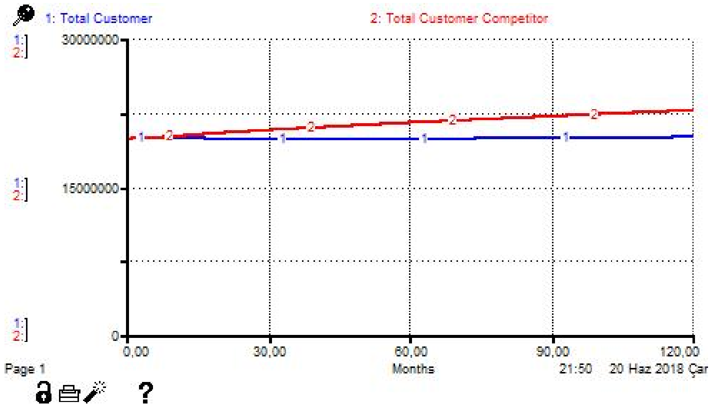



Figure 4.35. Very High Contract Price Case; Total Customers


Figure 4.36. Very High Contract Price Case; Profits

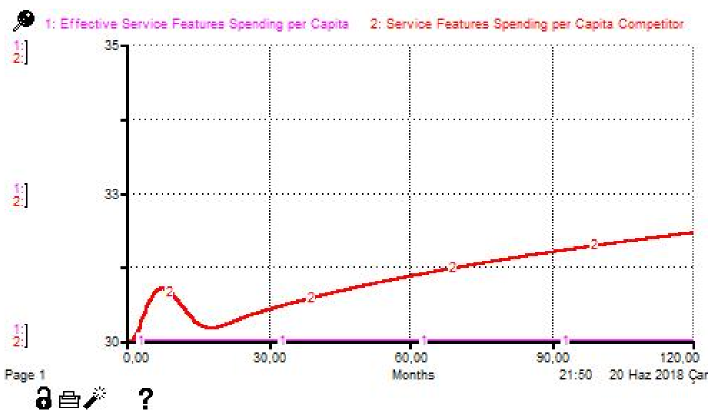



Figure 4.37. Very High Contract Price Case; Service Features Spending

advertising spending drops below a critical point, the company loses all customers.

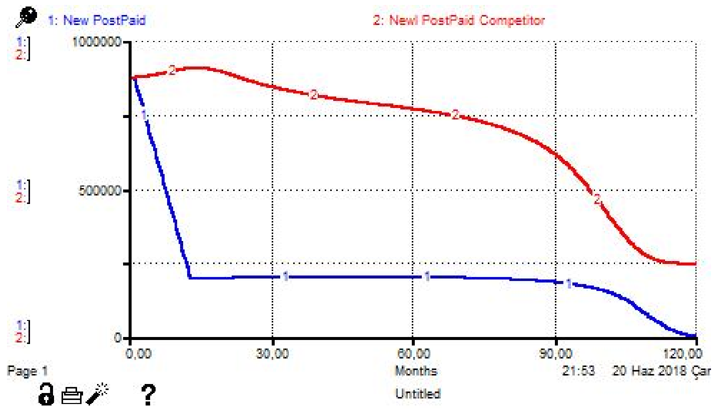



Figure 4.38. Very Low Advertising Spending Case; New Postpaid Segment Customers

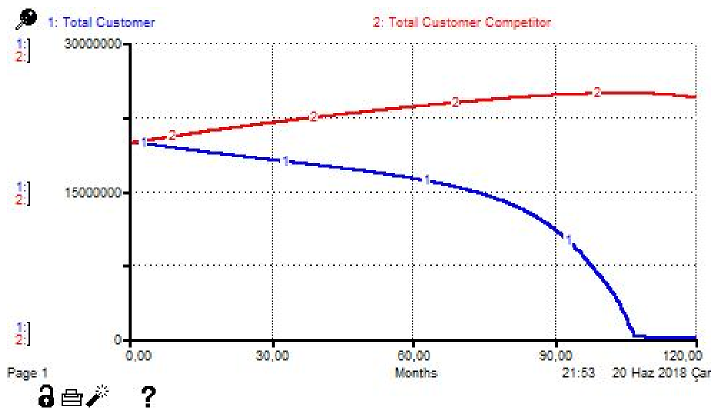



Figure 4.39. Very Low Advertising Spending Case; Total Customers

#### 4.2.6. Company's Advertising Spending Very High

In this case it is checked if the model behaves valid when the advertising spending is made very high (100M TL per month). First an increase in the acquisition of new customers observed because more customers are attracted to join the company. However, due to the excessive spending on investment, profit of the company decreases. Because of the low profit level, *effective advertising spending* of the company decreases through time. First the company, then the competitor lose their customers because of the adverse market condition.

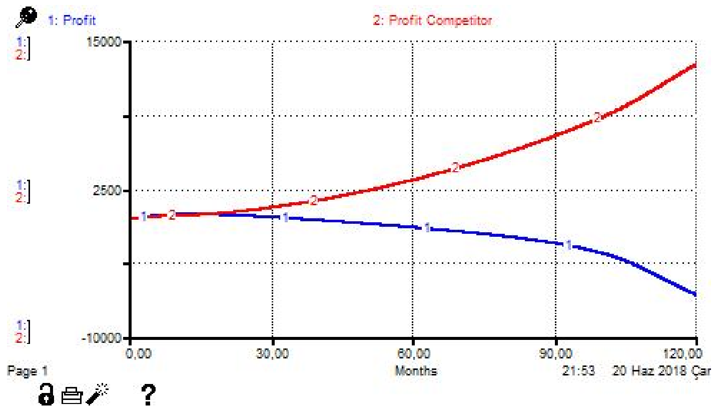



Figure 4.40. Very Low Advertising Spending Case; Profits

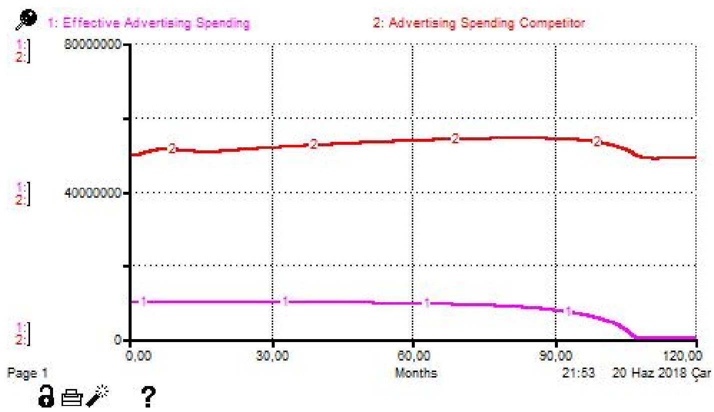



Figure 4.41. Very Low Advertising Spending Case; Advertising Spending

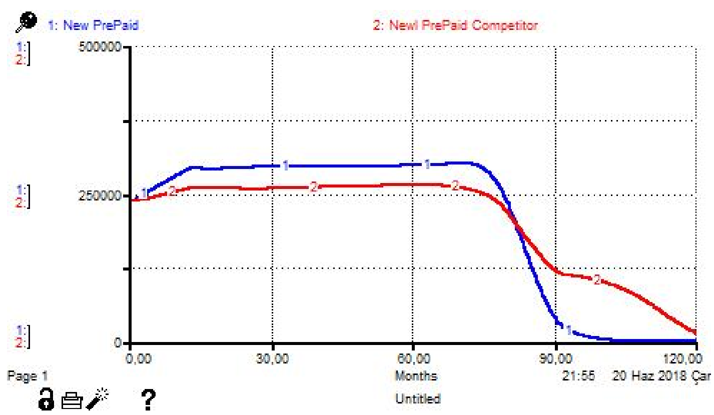



Figure 4.42. Very High Advertising Spending Case; New Prepaid Segment Customers

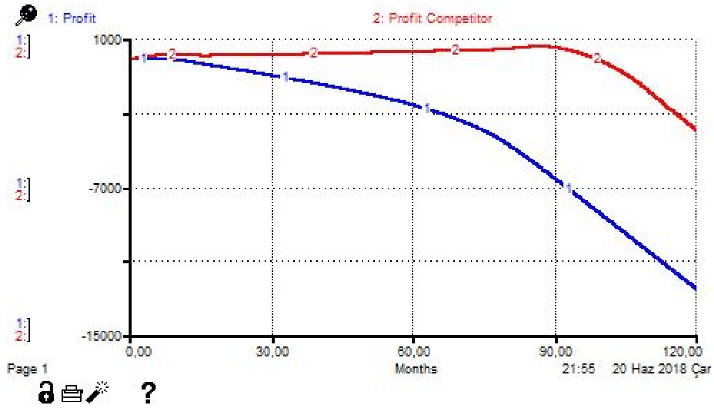



Figure 4.43. Very High Advertising Spending Case; Profits

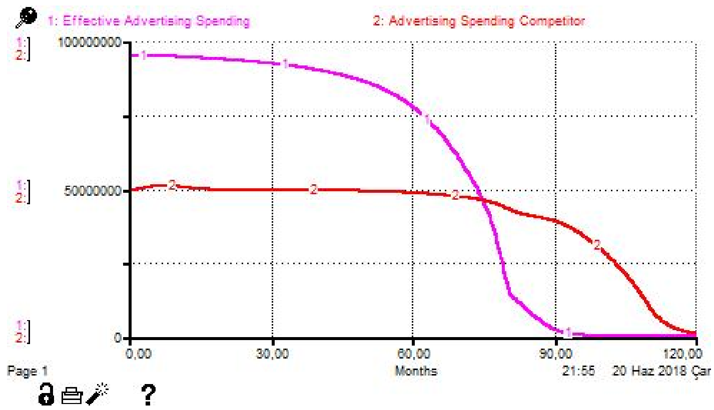



Figure 4.44. Very High Advertising Spending Case; Advertising Spending

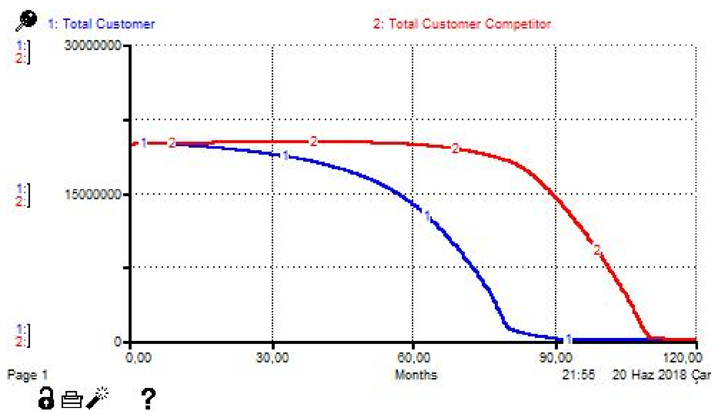



Figure 4.45. Very High Advertising Spending Case; Total Customers

## 4.3. Sensitivity Analysis

In this section, model sensitivity to the values of some key parameters is observed. To do so, several simulation runs are taken with different values of the specific parameters and the outputs are compered.

### 4.3.1. Response Delay for Investment

In order to observe the sensitivity, the value of the response delay is taken 4(base), 10, 20, 50 and 120 months respectively. It is observed that, in terms of number of customers, the competitor becomes worse off as the delay is increased. On the other hand, profitability is increasing as the delay goes up. See Figures 4.46, 4.47, 4.48 and 4.49.

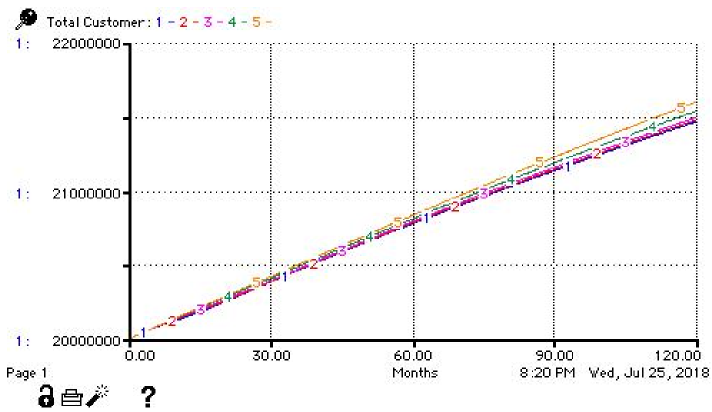



Figure 4.46. Sensitivity Run for Response Delay for Investment; Total Customers - Company

### 4.3.2. Response Delay for Price

In order to observe the sensitivity to *response delay for price*, *postpaid acquisition price* is set to 45 TL per month (80% of the normal price). In the sensitivity runs, the value of the response delay is taken 2(base), 5, 10, 25 and 60 months respectively. It is observed that, the profitability of the company is increasing as the delay goes up. See

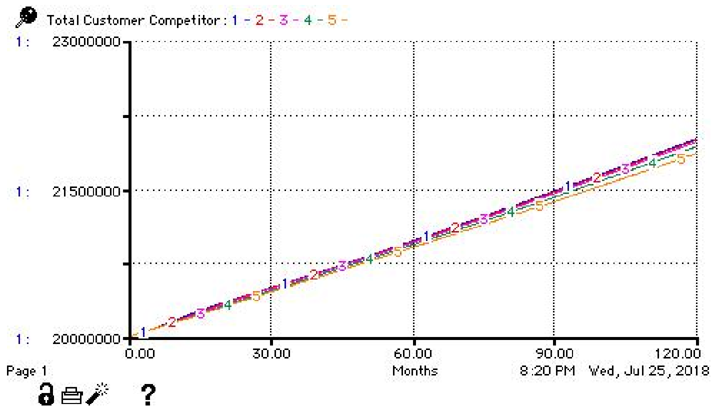



Figure 4.47. Sensitivity Run for Response Delay for Investment; Total Customers - Competitor

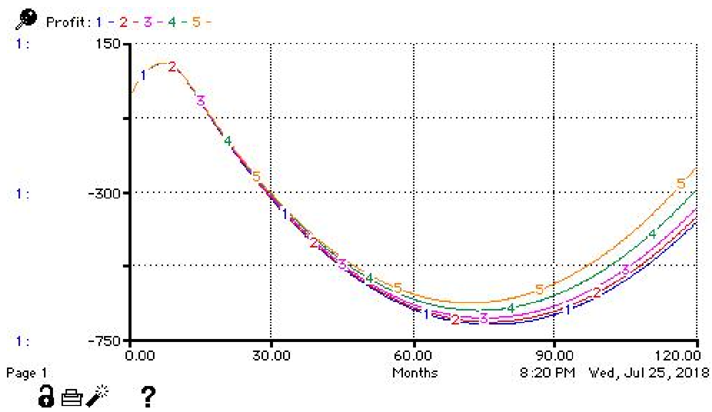



Figure 4.48. Sensitivity Run for Response Delay for Investment; Company Profit

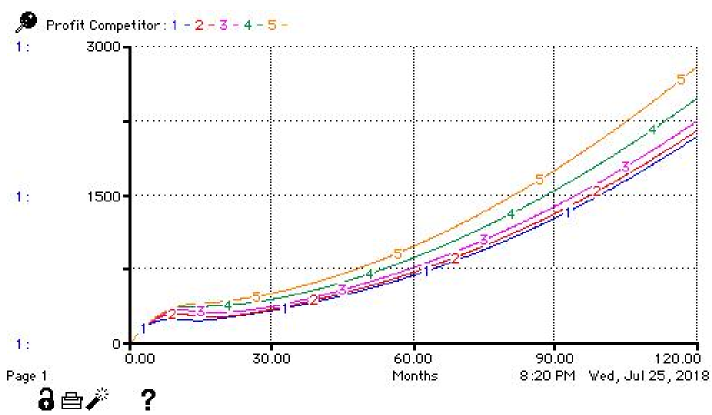



Figure 4.49. Sensitivity Run for Response Delay for Investment; Competitor Profit

Figures 4.50 and 4.51.

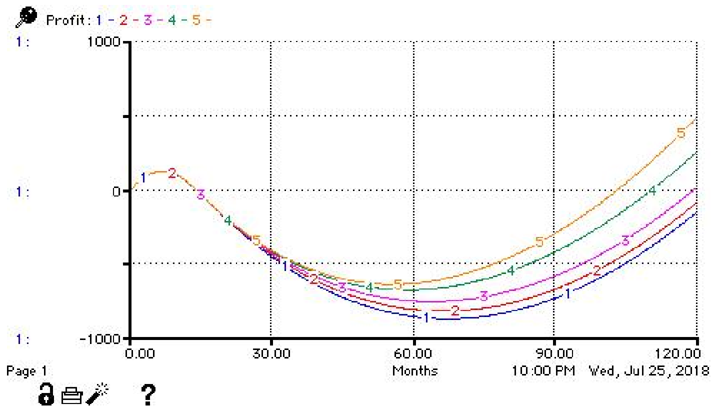



Figure 4.50. Sensitivity Run for Response Delay for Price; Company Profit

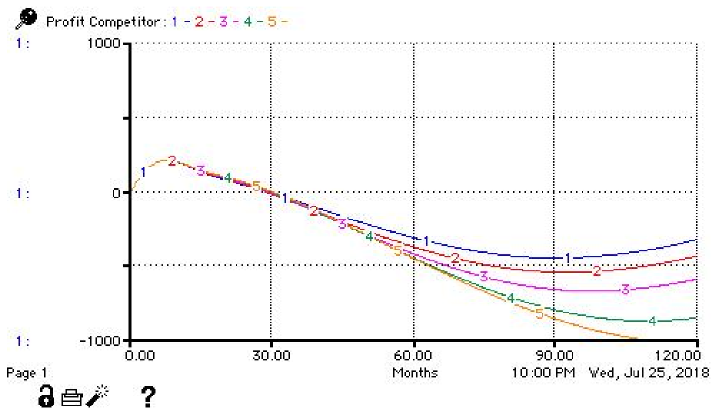



Figure 4.51. Sensitivity Run for Response Delay for Price; Competitor Profit

### 4.3.3. CAPEX

In order to observe the sensitivity to *CAPEX* variable, the base model is used. In the sensitivity runs, the value of the parameter is taken 150M, 180M, 200M(base), 230M and 250M TL per month respectively. It is observed that, over a certain value for *CAPEX*, both companies go bankrupt. And as expected, as *CAPEX* value is decreased, profits and number of customers of both companies increase.

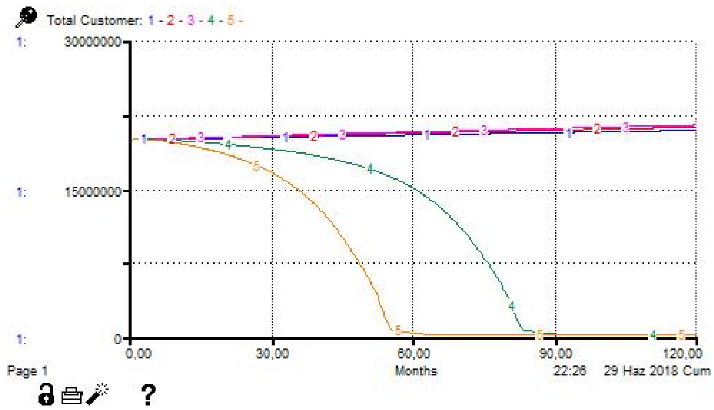



Figure 4.52. Sensitivity Run for CAPEX; Total Customers - Company

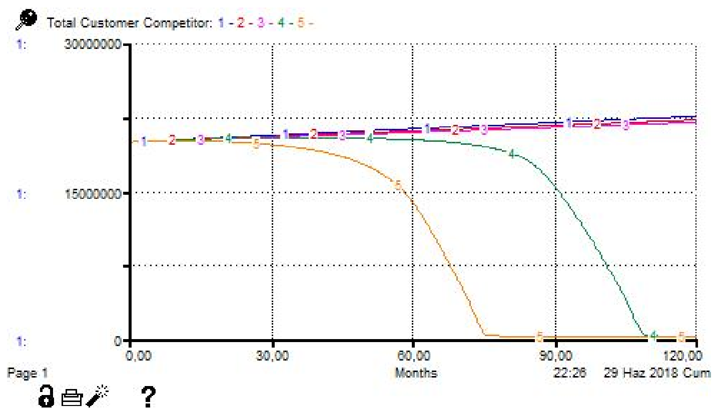



Figure 4.53. Sensitivity Run for CAPEX; Total Customers - Competitor

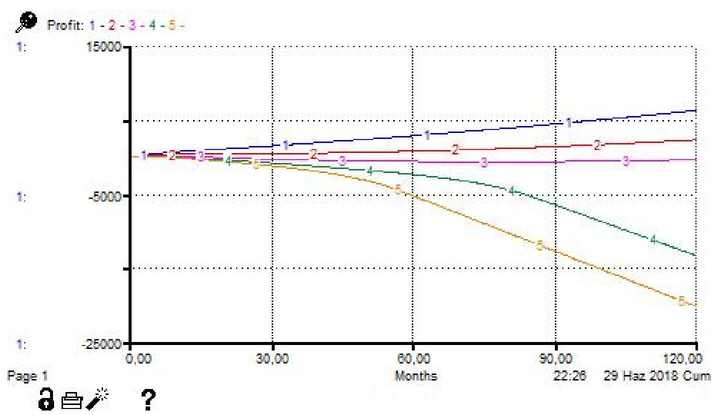



Figure 4.54. Sensitivity Run for CAPEX; Company Profit

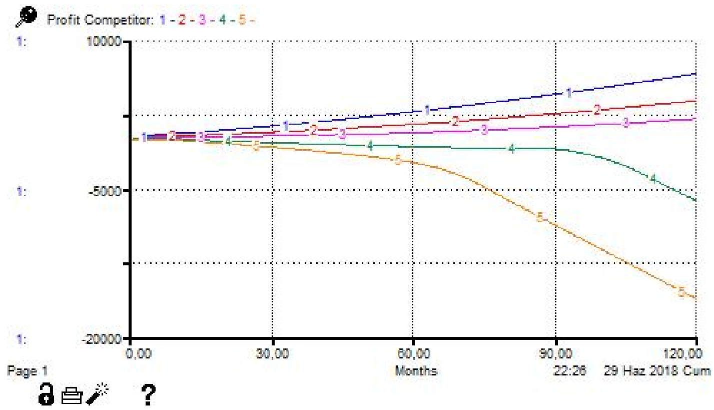



Figure 4.55. Sensitivity Run for CAPEX; Competitor Profit

### 4.3.4. Overspending Coefficient

In order to observe the sensitivity to *overspending coefficient*, *postpaid acquisition price* is set to 30 TL per month (half of the normal price). In the sensitivity runs the value of the coefficient is taken 0%, 1%, 3%(base), 5% and 10% respectively. It is observed that in the initial stages both companies need to overspend, otherwise they go bankrupt. On the other hand, over a certain value, *overspending coefficient* has no effect on the model behavior because companies do not need to spend more than this certain fraction.

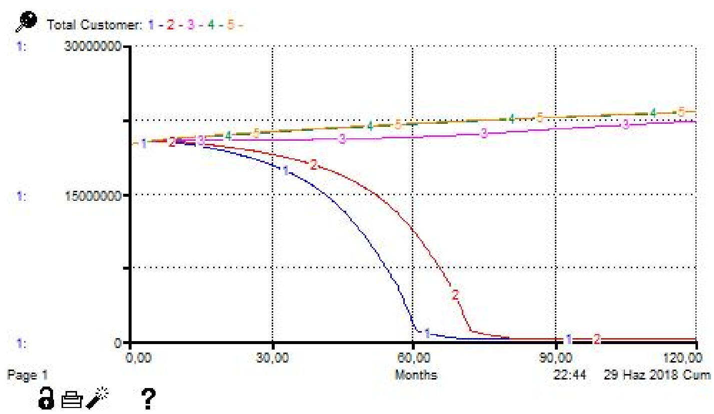



Figure 4.56. Sensitivity Run for Overspending Coefficient; Total Customers - Company

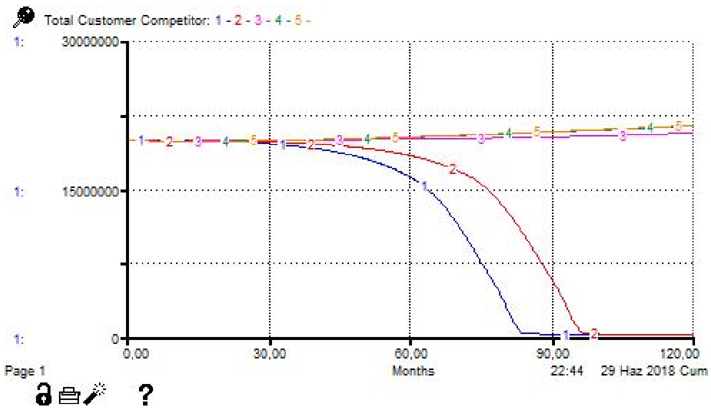



Figure 4.57. Sensitivity Run for Overspending Coefficient; Total Customers - Competitor

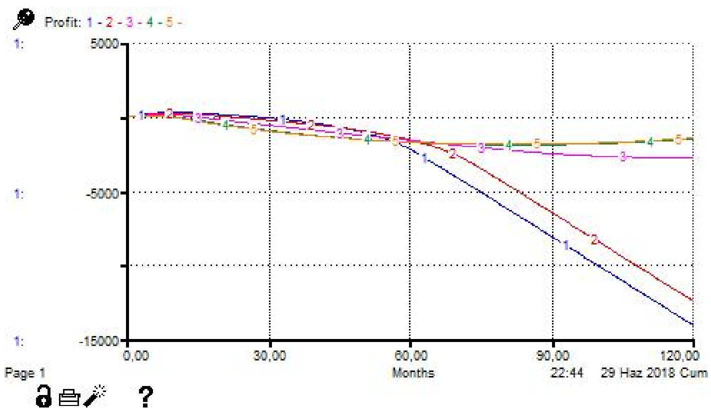



Figure 4.58. Sensitivity Run for Overspending Coefficient; Company Profit

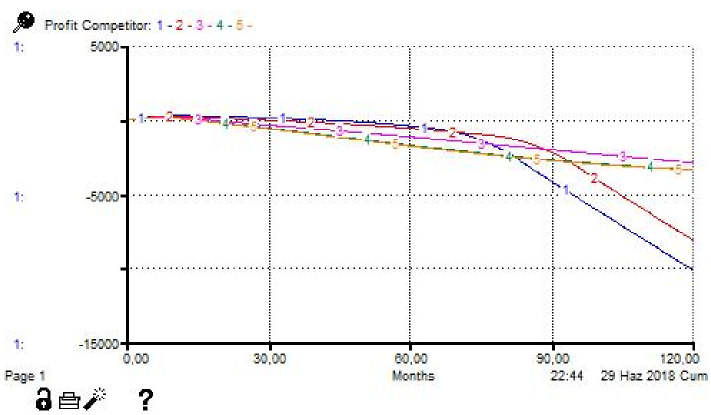



Figure 4.59. Sensitivity Run for Overspending Coefficient; Competitor Profit

# 5. WEB GAME DEVELOPMENT

As mentioned before, in order for players to test management strategies with the simulation model, a game version is designed and published online. The latest version of *Stella* simulation software, called *Stella Architect*, allows online publishing of the system dynamics models and interfaces. Hence, an interface is designed for game version in the software and a web link is generated to reach the game online.

## 5.1. Game Interface Design

The web game is configured to last 120 months and the decision interval is set to 3 months. The player can adjust decision variables every three months and run the simulation to observe the results. The corresponding competitor actions are generated by the model. Interface for the game is designed to provide the above functions and display the dynamics of main variables (key performance indicators).

### 5.1.1. Main Screen

Main screen is designed to observe *KPI* values, the competitor responses and for navigation to the other screens (Figure 5.1). On top of the screen, there is *timer* (showing the current period), *all customers* in the market (the company, the competitor and the *market other*), *percentage market share* of the company, and *total number of customers* of the company and the competitor. The player should input decision variables that are set to normal values at the beginning. The explanations for the decision variables are as follows:

*Acquisition Price Pre*: Acquisition price offered to non-company customers to join prepaid segment.

*Internal Price Pre*: Retention price offered to Company's own customers to stay in prepaid segment.

*Acquisition Price Post*: Acquisition price offered to non-company customers to join postpaid segment or Company's own customers to switch to postpaid segment.

*Internal Price Post*: Retention price offered to Company's own customers to stay in postpaid segment without a contract.

*Contract Price*: Retention price offered to Company's own customers to stay in postpaid segment with a contract.

*Desired Advertising Spending*: Desired monthly budget for advertising spending. (Called desired, because it can be met only if the profitability of the company allows)

*Desired Service Features Spending per Capita*: Desired monthly spending per customers for service features investments. (It can be met, only if the profitability of the company allows)

*Desired Service Quality Spending*: Desired monthly budget for service quality investments. (It can be met, only if the profitability of the company allows)

Competitor decision responses are shown very next to the respective decision variables of the company and changed dynamically. These variables are conjugates of the decision variables of the company. Response values are calculated internally by the system dynamics model. *Contract price* is not included here because it is a feature of the company only.

The player can run the simulation for one period (3 months) via *Run* button and restart the simulation with *Reset* button. Other four buttons are for the navigation to the indicated screens.

Below the navigation buttons, current *profit* values and graphs for profits, revenues and the costs are shown. The player can observe the changes in these KPI's through time and adjust the decision actions accordingly.

Finally, at the left bottom the player can observe the base value list for the decision variables. This list is given to the player for reference to measure how much deviated are the current values of the decision variables from the reference values. In addition to this, they can be useful in calculating *projected cost* in the next period.

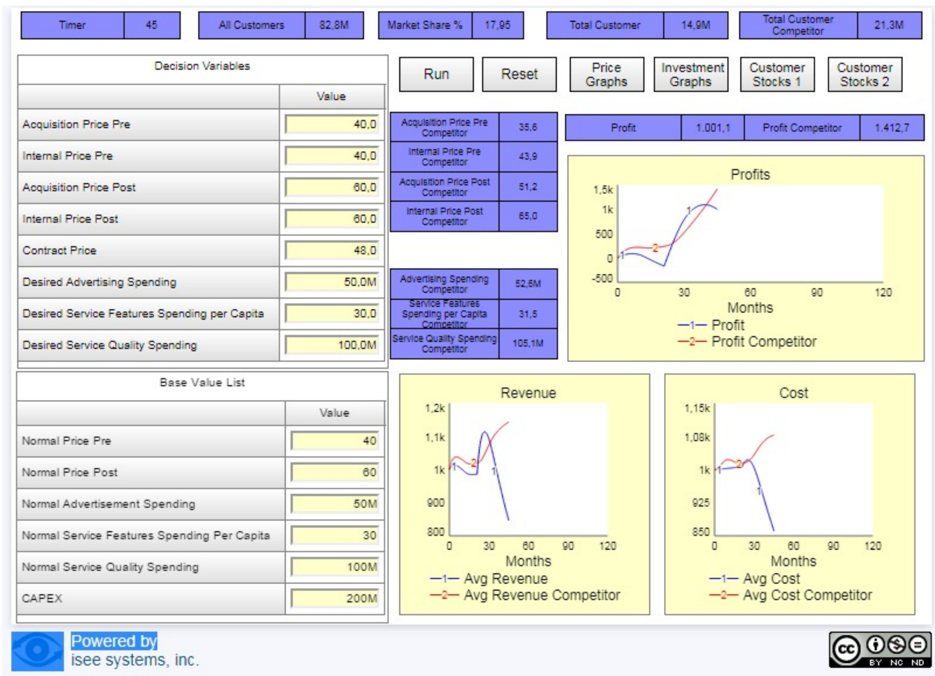



Figure 5.1. Main Screen of the Web Game

### 5.1.2. Price Graphs

In this screen, the player can observe the price changes and compare with the competitor's. The only button at the top returns to the main screen.

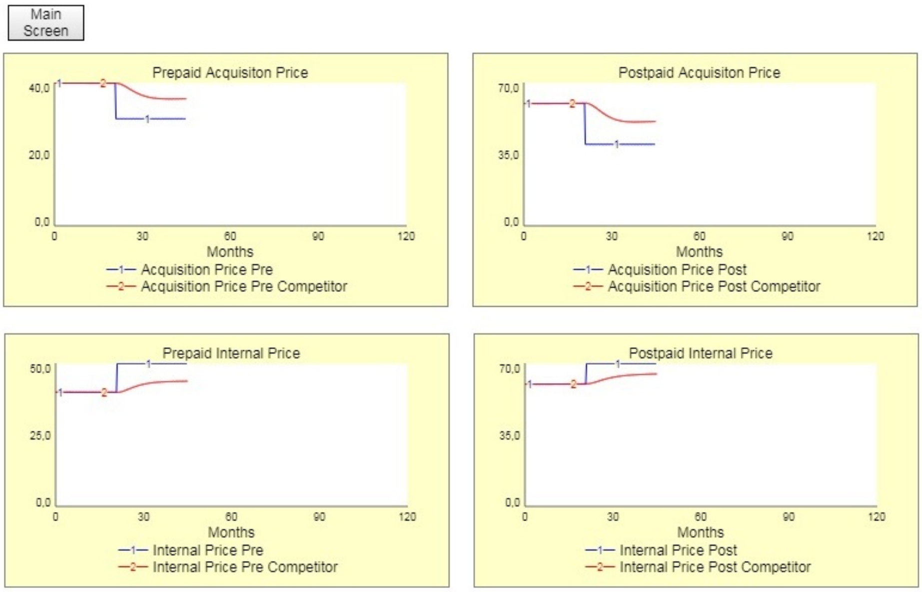



Figure 5.2. Price Graphs of the Web Game

### 5.1.3. Investment Graphs

In this screen, the player can observe the investment spending changes and compare with the competitor's. The graphs on the left shows the effective spending and the other ones show the perceived values of the investment spending. As mentioned before, perception of the effective spending by the customers takes time. The only button at the top returns to the main screen. See Figure 5.3.

### 5.1.4. Customer Stocks

To observe the number of customers there are two screens. In the first one, total numbers and the numbers by the segments are shown (Figure 5.4). The second one is for more detailed observation (Figure 5.5). The player can analyze every customer stock and design the strategy accordingly. The only button at the top returns to the main screen.

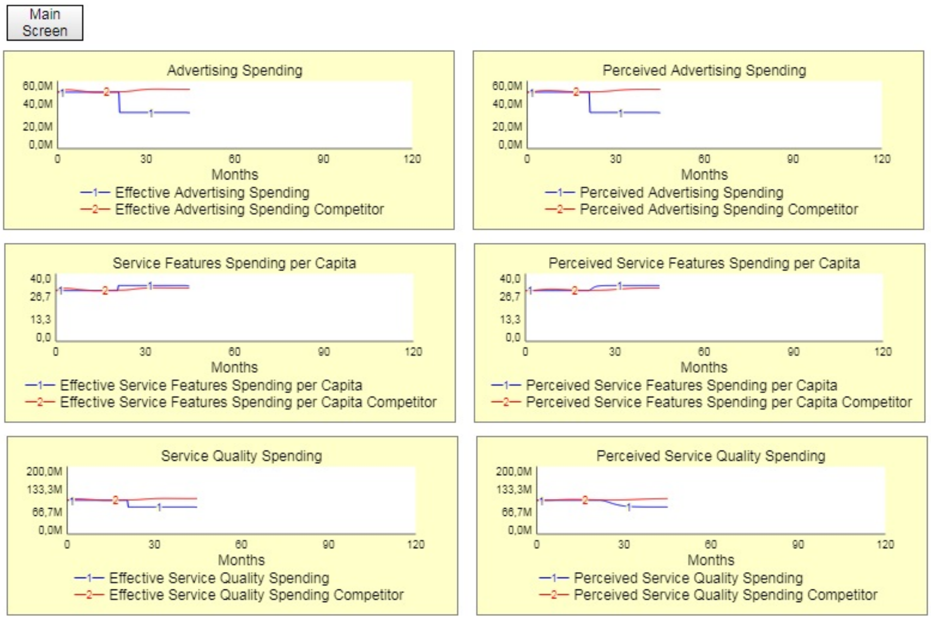



Figure 5.3. Investment Graphs of the Web Game

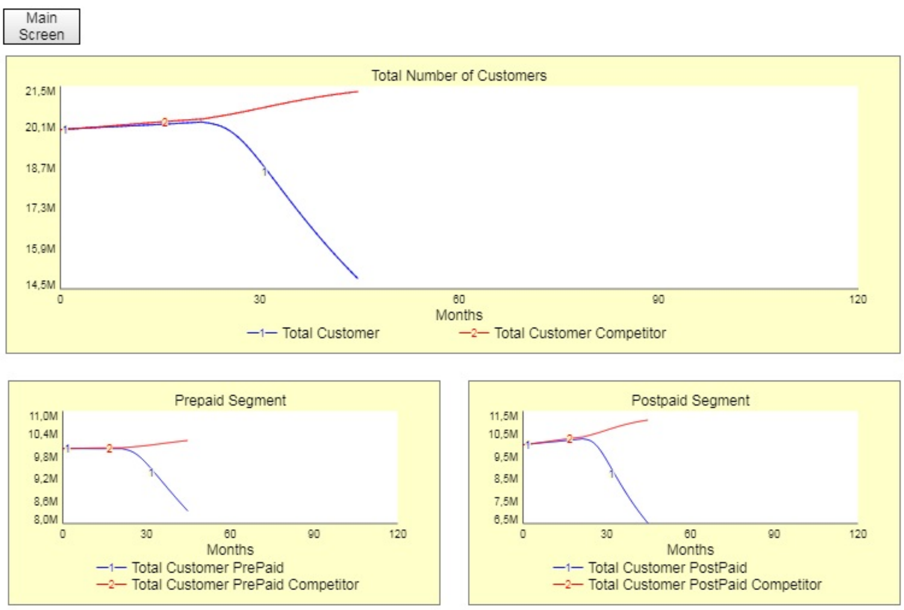



Figure 5.4. Total Customer Stock Graphs of the Web Game

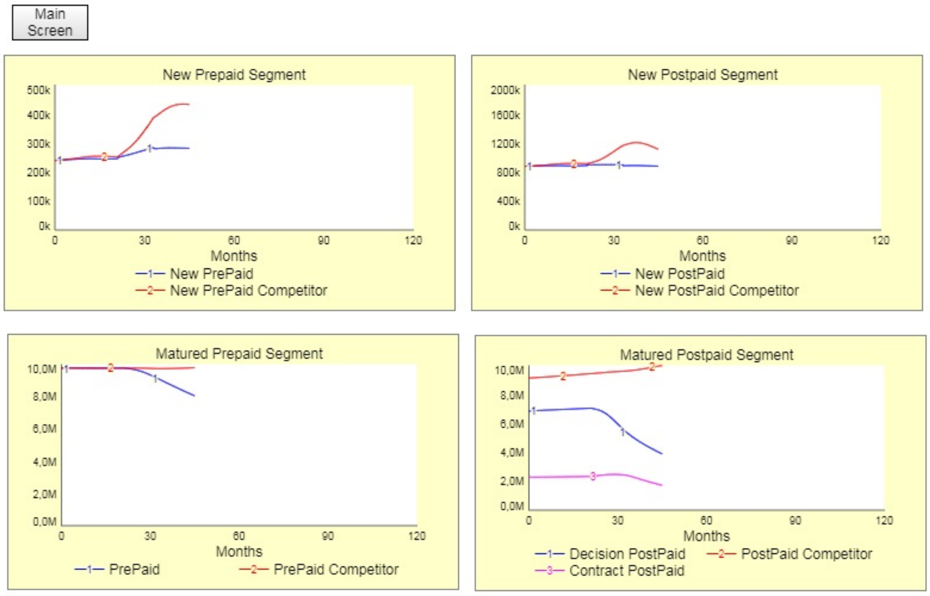



Figure 5.5. Segment Customer Stock Graphs of the Web Game

## 5.2. Scenario Analysis

In this section three possible game scenarios are analyzed. In the first one, the player keeps the initial decisions through the game, in which case the competitor slightly outperforms the player. In the second one a poor player performance and market collapse is observed. And in the final scenario the player outperforms the competitor.

### 5.2.1. Base Scenario

In this scenario, the player inputs only the base values for the entire game period. As a result, the competitor generates a suitable response mechanism and finishes better than the player.

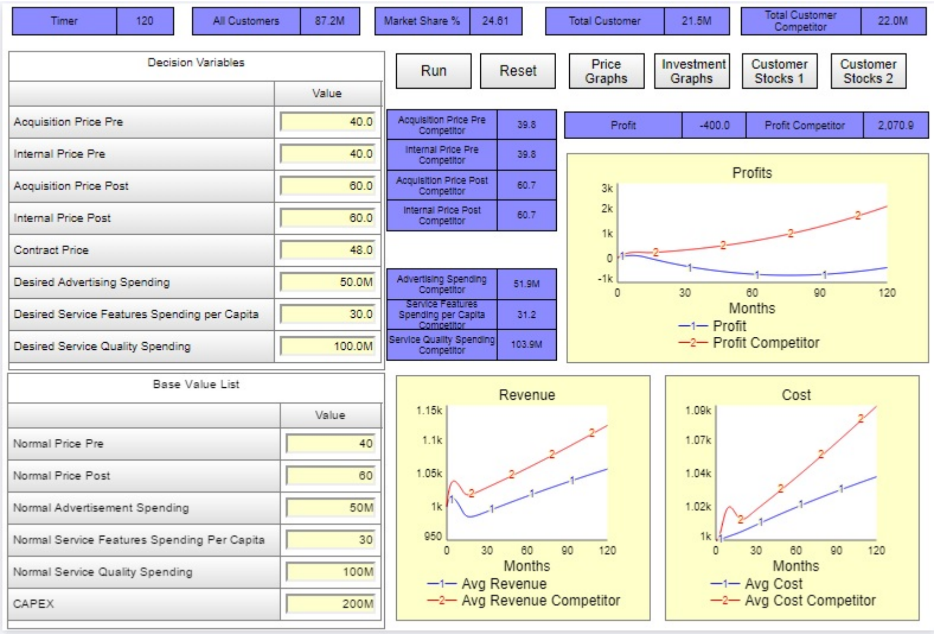



Figure 5.6. Base Scenario; KPI's

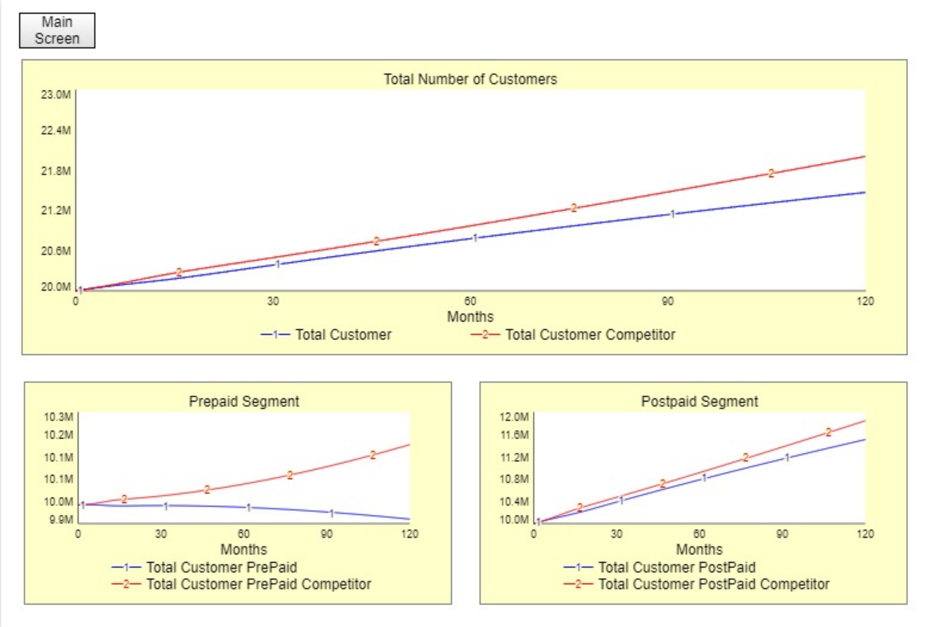



Figure 5.7. Base Scenario; Customers

### 5.2.2. Poor Player Performance Scenario

In this scenario, the player offers slightly lower prices for internal customers and higher prices for external customers. In addition to this, the player allocates more of the investment budget to service quality and features spending, rather than advertising spending. The aim of this strategy is to obtain a low churn rate instead of a high acquisition rate, in favor of internal customers. However, due to low profitability, it was not possible for the player to cover desired investment costs and to keep internal customers satisfied. The player gradually loses its market share during the game period. On the other hand, the competitor manages to increase its market share and profit accumulation. See Figures 5.8, 5.9, 5.10 and 5.11 below.

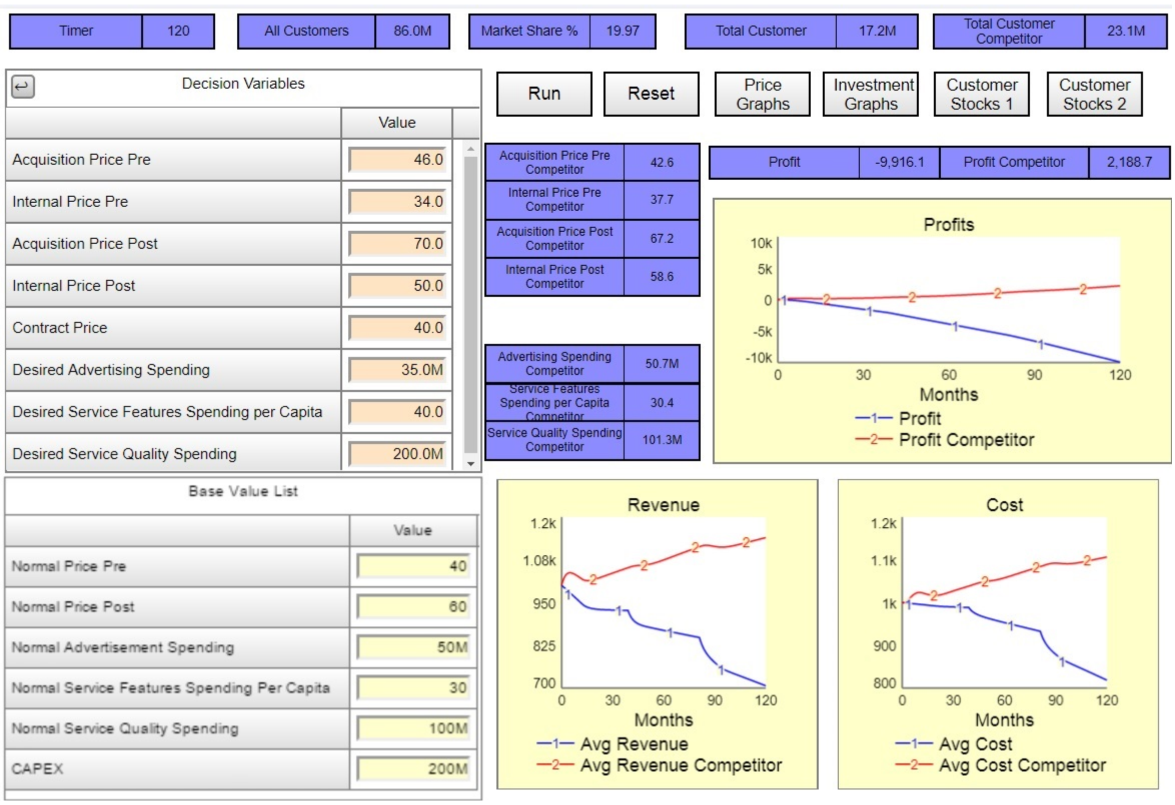



Figure 5.8. Poor Player Performance Scenario; KPI's


Figure 5.9. Poor Player Performance Scenario; Prices

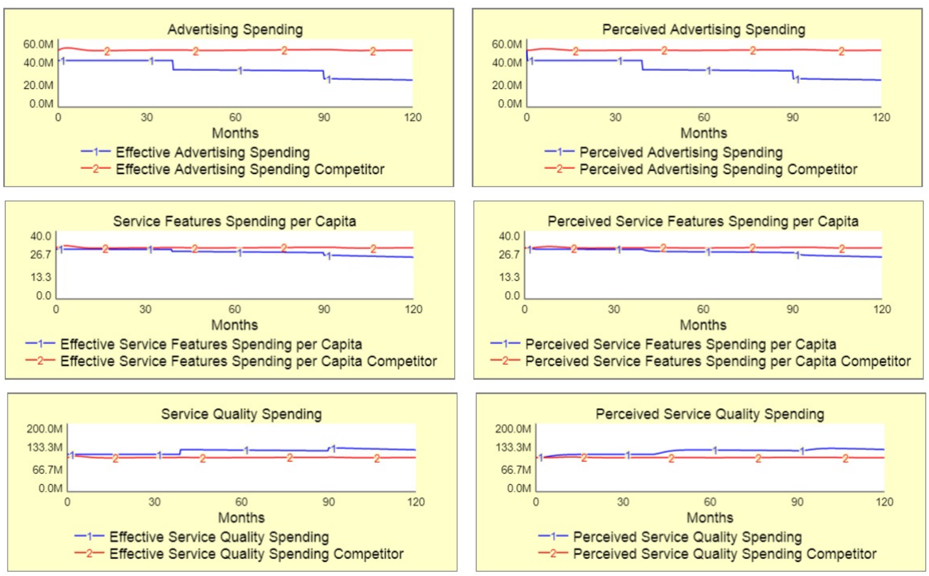



Figure 5.10. Poor Player Performance Scenario; Investments

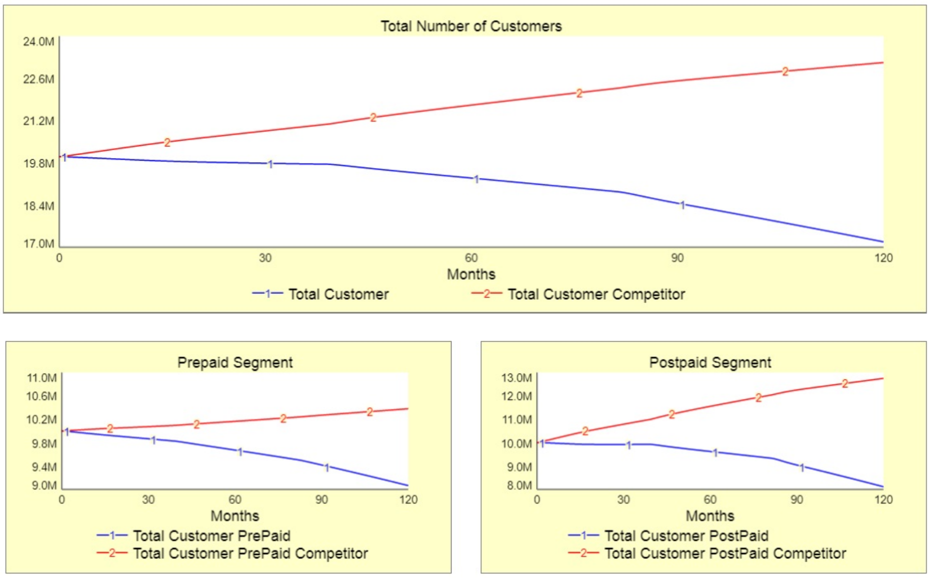



Figure 5.11. Poor Player Performance Scenario; Customers

### 5.2.3. Poor Player Performance and Market Collapse Scenario

In this scenario, the player offers lower prices for all segments. This strategy brings more customers to the player initially, but, the player cannot provide the necessary investments and rapidly loses customers. The competitor, in order to cope with low market prices, cuts off its prices as well and lowers its expenses. After a while, it also goes to bankrupt. See Figures 5.12, 5.13, 5.14 and 5.15 below.

### 5.2.4. Successful Player Scenario

In this scenario, the player sets slightly lower acquisition prices and slightly higher internal prices in both segments. She also supports her customer gain strategy with slightly higher advertising spending. During the simulation period, the player continues to gradually decrease the acquisition prices and increase the internal prices. This strategy benefits from the inertia of internal customers who are paying higher prices, but do not take a rapid action to churn out. In the end, the player reaches a greater market cap and profit amount than the competitor. See Figures 4.16, 4.17 and 4.18.

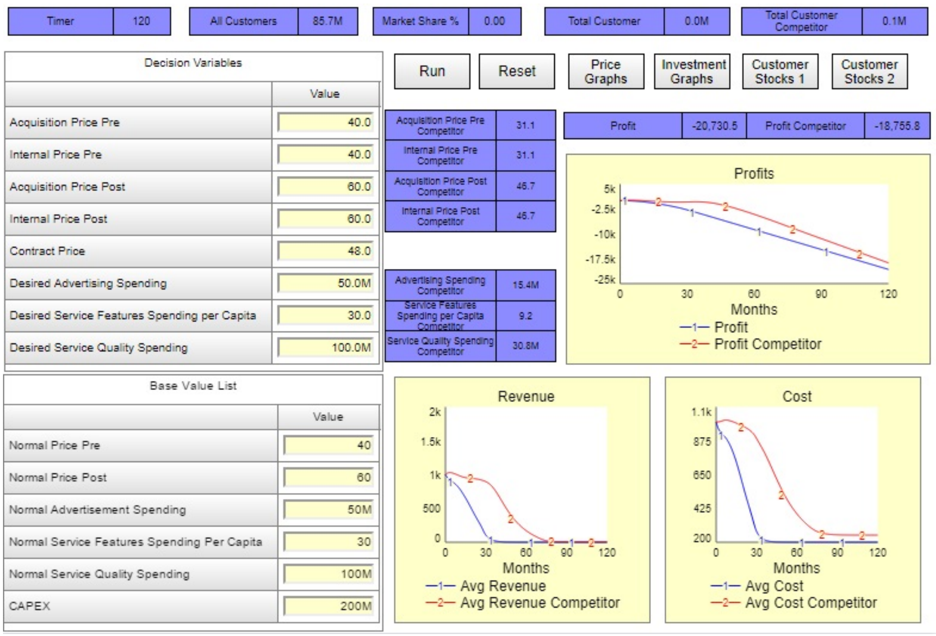



Figure 5.12. Poor Player Performance and Market Collapse Scenario; KPI's

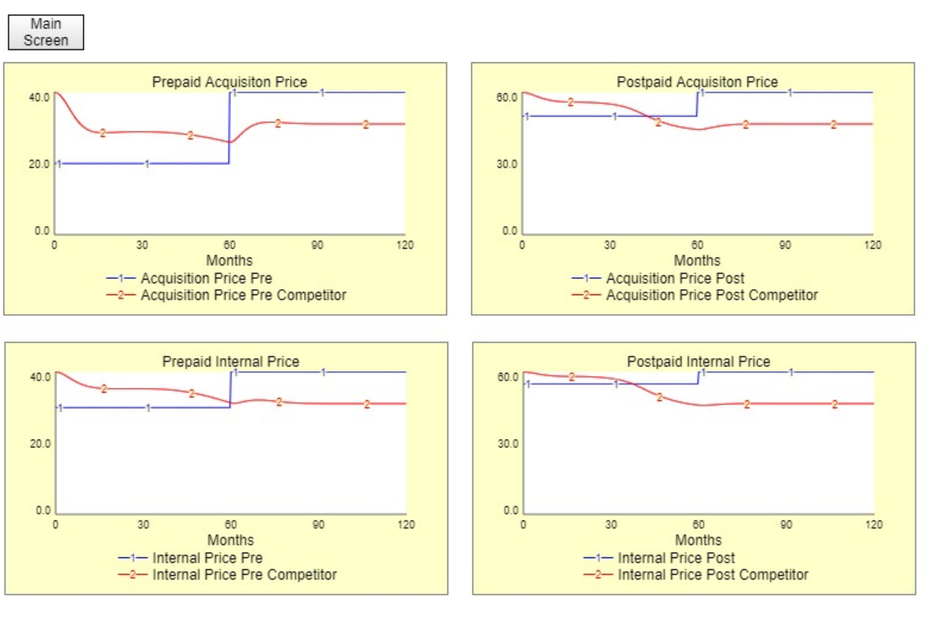



Figure 5.13. Poor Player Performance and Market Collapse Scenario; Prices

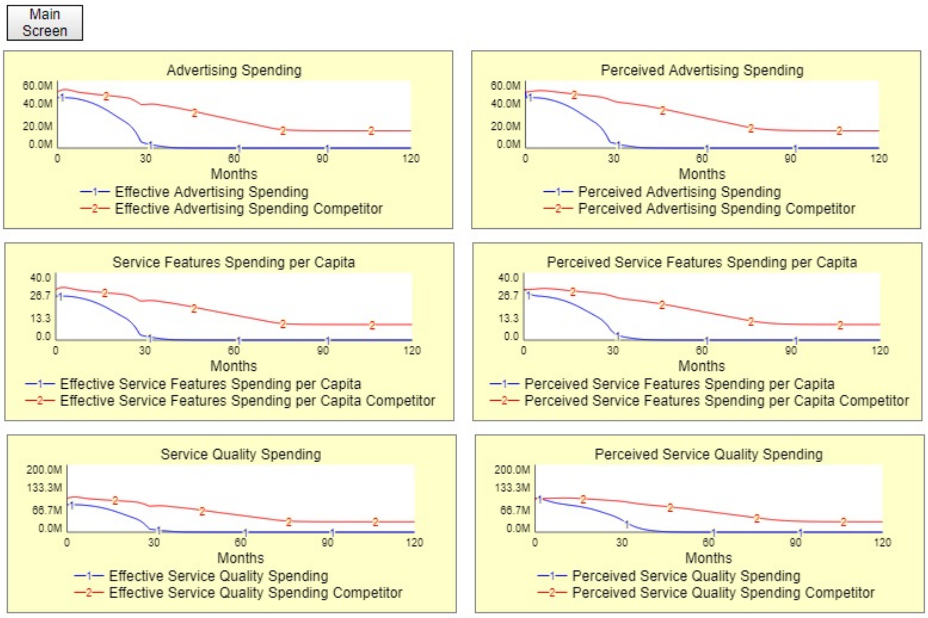



Figure 5.14. Poor Player Performance and Market Collapse Scenario; Investments

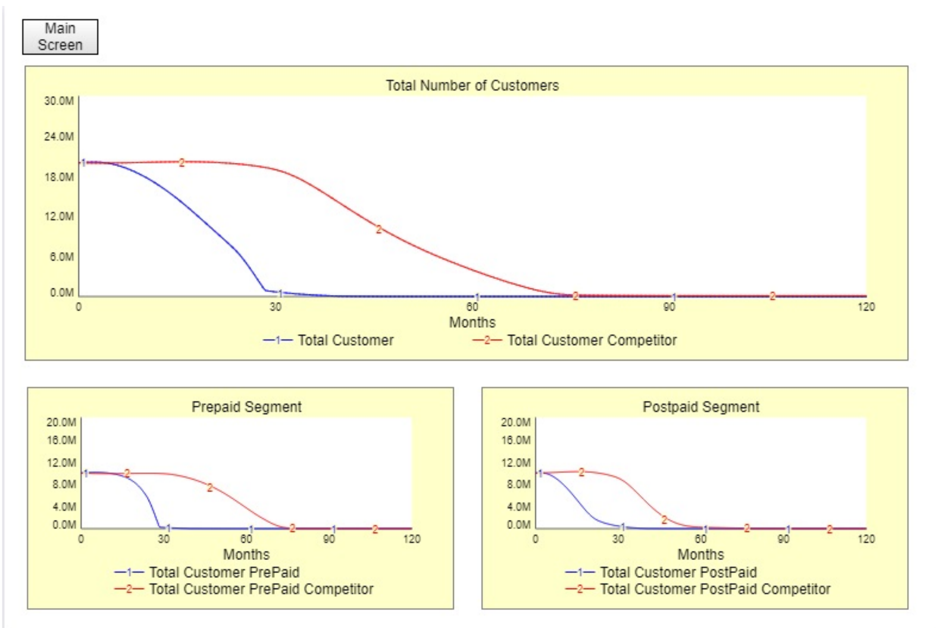



Figure 5.15. Poor Player Performance and Market Collapse Scenario; Customers

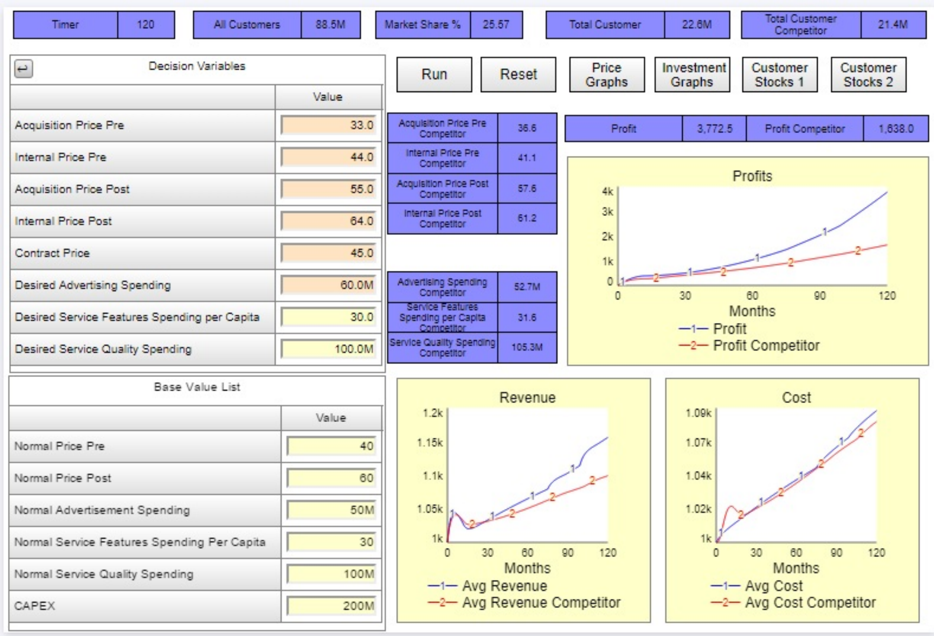



Figure 5.16. Successful Player Scenario; KPI's

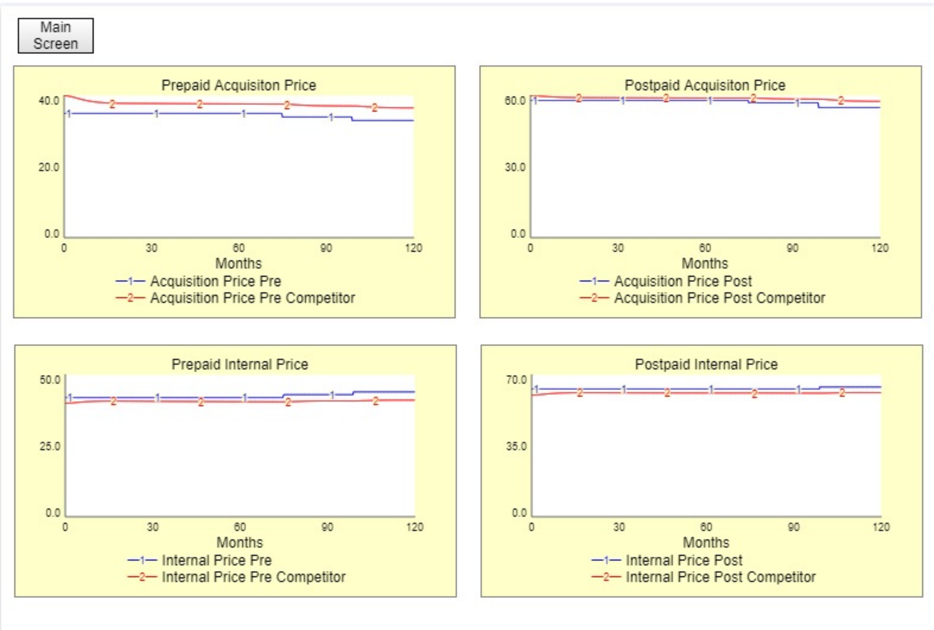



Figure 5.17. Successful Player Scenario; Prices

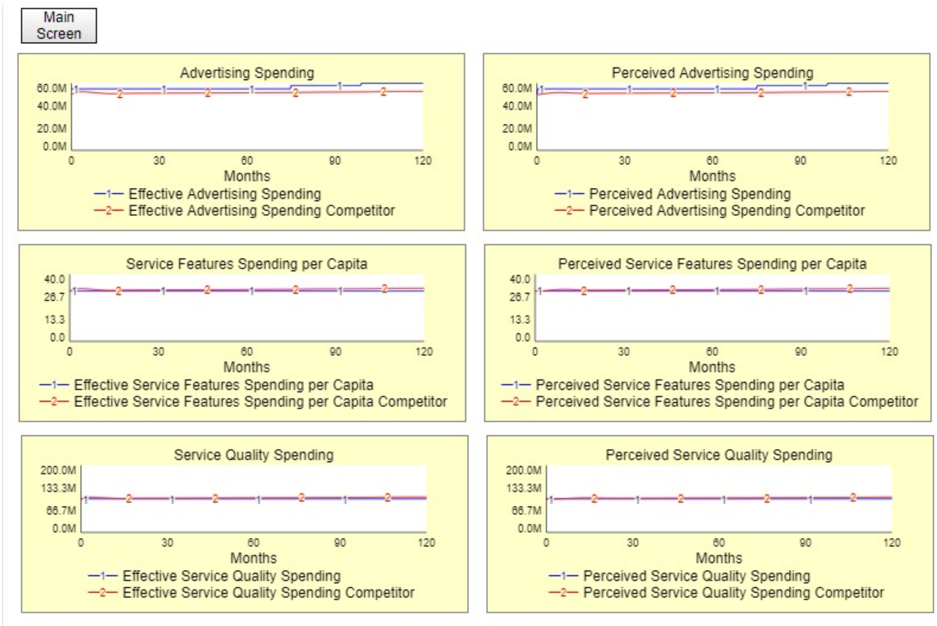



Figure 5.18. Successful Player Scenario; Investments

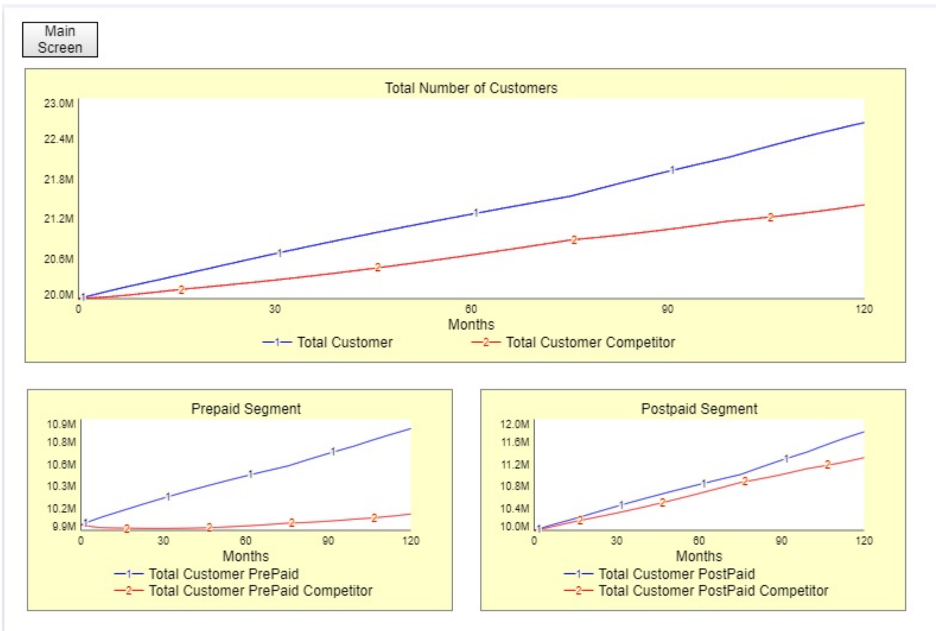



Figure 5.19. Successful Player Scenario; Customers

# 6. CONCLUSION

Management of a company is a difficult problem in mobile communications market where rapid customer circulation between large budgeted firms exists. To come up with an optimal strategy to maximize performance metrics is not possible because of the complex and dynamic nature of problem. System dynamics methodology is a convenient approach for building simulation models to represent such complex problems and testing suggested management strategies. For this purpose, a system dynamics simulation model and an interactive game version are built.

Key performance variables in the model are market share and profitability of two competing companies. To achieve a success, companies must decide on the proper levels of price and necessary investments. Prepaid and postpaid segment customers are separately modeled, and acquisition and retention prices are distinguished for the external and internal customers respectively. Scope for investment spending are defined as advertising, and service features and service quality investments. Customers make their decisions according to price offerings and the perceived levels of investments of two companies. The flow of the customers in between the companies and revenues generated by them constitute market dynamics. After the completion of the model, it is tested under extreme conditions to evaluate its structural validity. Furthermore, sensitivity analysis is carried out with some selected model parameters to determine their valid ranges and assess model credibility.

The simulation model is next transformed into a web game in which a player enters every three months eight decision variables for a company. The competitor response to these decisions in each round are generated by built-in formulations in the model. During the game, the player can observe the current performance measures and their historical dynamics and decide about his or her strategy. Numerous test games performed on the web game indicate that a stable market growth or a definite market collapse is possible as a result of the actions of the competing firms.

Obtained results show that a successful strategy consists of a high acquisition rate and above average amount of investment. Advertising and low acquisition prices may be used to attract customers and to keep the acquired customers in the company, service features and quality investments should be increased. With this strategy, the company may charge relatively higher prices to its customers and increase the revenue and the profit, and the market cap at the same time.

On the other hand, it is demonstrated that a poor strategy of the player may result in a collapse of the entire market. Charging below the average fees to the customers without an adequate investment leads to bankruptcy of the company. It is explained that to provide the necessary amounts of investment, companies should have a sufficient profitability. In the two poor player performance scenario, it is shown that offering low acquisition prices causes a price war between competing companies and eventually the collapse of the market. However, if the company offers relatively lower prices only to internal customers, then the competitor manages to increase the market share and profit accumulation, without a *death spiral*.

Extensive tests and experiments with the web game indicate that it is a promising tool for real-life decision makers to test their business strategies against a competitor. In future research, the generic game version may be converted to a professional game in which a more realistic customer segmentation is made and a specific management problem is analyzed. Furthermore, a mathematical analysis could be made to find valid ranges for specific parameters and initial values of some variables that are responsible for the outcome dynamics. As a result of such an analysis, the simulation model with a different setting may create a healthy market growth. Finally, the model is suitable to be modified and used in different service industries that require customer subscription, such as energy distribution market or digital entertainment content providers.

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# APPENDIX A: MODEL STOCK FLOW DIAGRAM

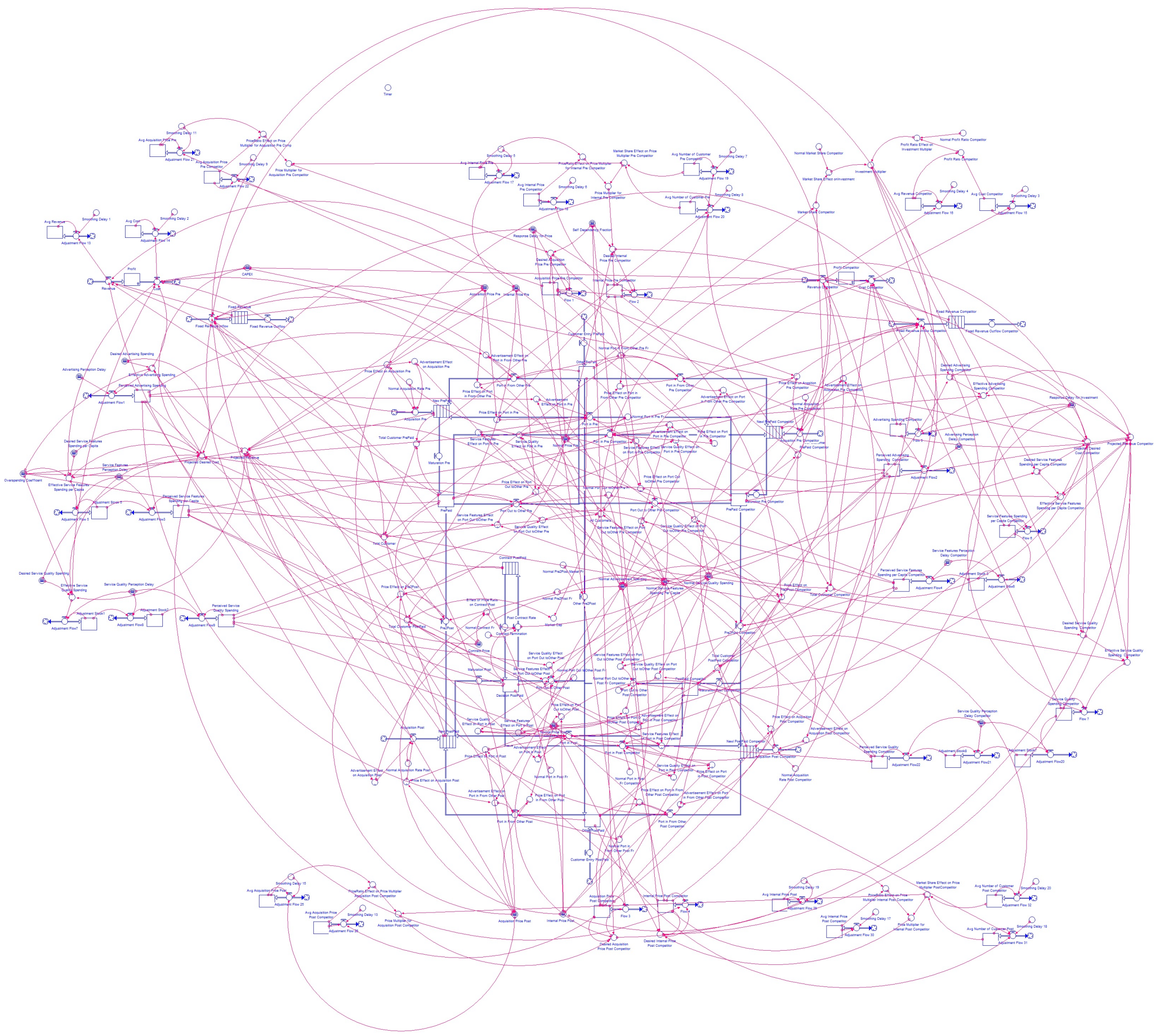

Figure A.1. Model Stock Flow Diagram

# APPENDIX B: BASE MODEL EQUATIONS

INITIALIZATION EQUATIONS:

: l Contract PostPaid = 2280000 TRANSIT TIME = 12 CAPACITY = INF INFLOW LIMIT = INF

: l Fixed Revenue = 225600000 TRANSIT TIME = 12 CAPACITY = INF INFLOW LIMIT = INF

: l Fixed Revenue Competitor = 120000000 TRANSIT TIME = 12 CAPACITY = INF INFLOW LIMIT = INF

: l New PostPaid Competitor = 880000 TRANSIT TIME = 12 CAPACITY = INF INFLOW LIMIT = INF

: l New PrePaid Competitor = 240000 TRANSIT TIME = 12 CAPACITY = INF INFLOW LIMIT = INF

: l New PostPaid = 880000 TRANSIT TIME = 12 CAPACITY = INF INFLOW LIMIT = INF

: l New PrePaid = 240000 TRANSIT TIME = 12 CAPACITY = INF INFLOW LIMIT = INF

: s Acquisition Price Post Competitor = 60

: c Response Delay for Price = 2

: c Self Dependency Fraction = 0.75

: c Normal Price Post = 60

: s Avg Number of Customer Post = 30000000

: s Avg Number of Customer Post Competitor = 10000000

: c Market Share Effect on Price Multiplier PostCompetitor = GRAPH (Avg Number of Customer Post Competitor * 3 / Avg Number of Customer Post) (0, 0.666), (0.5, 0.8), (1, 1), (1.5, 1.25), (2, 1.5)

: s Avg Acquisition Price Post Competitor = 60

: s Avg Acquisition Price Post = 60

: c PriceRatio Effect on Price Multiplier Acquisition Post Competitor = GRAPH (Avg Acquisition Price Post Competitor / MIN (80, Avg Acquisition Price Post)) (0, 2), (0.333, 1.667), (0.667, 1.25), (1, 1), (1.333, 0.8), (1.667, 0.6), (2, 0.5)

: c Price Multiplier for Acquisition Post Competitor = Market Share Effect on Price Multiplier PostCompetitor * PriceRatio Effect on Price Multiplier Acquisition Post Competitor

: c Desired Acquisition Price Post Competitor = Self Dependency Fraction * Acquisition Price Post Competitor + (1 - Self Dependency Fraction) * Normal Price Post * Price Multiplier for Acquisition Post Competitor

: b Flow 3 = (Desired Acquisition Price Post Competitor - Acquisition Price Post Competitor) / Response Delay for Price

: s Acquisition Price Pre Competitor = 40

: c Normal Price Pre = 40

: s Avg Acquisition Price Pre Competitor = 40

: s Avg Acquisition Price Pre = 40

: c PriceRatio Effect on Price Multiplier for Acquisition Pre Comp = GRAPH (Avg Acquisition Price Pre Competitor / MIN (60, Avg Acquisition Price Pre)) (0, 2), (0.333, 1.667), (0.667, 1.25), (1, 1), (1.333, 0.8), (1.667, 0.6), (2, 0.5)

: s Avg Number of Customer Pre = 30000000

: s Avg Number of Customer Pre Competitor = 10000000

: c Market Share Effect on Price Multiplier Pre Competitor = GRAPH (Avg Number of Customer Pre Competitor * 3 / Avg Number of Customer Pre) (0, 0.666), (0.5, 0.8), (1, 1), (1.5, 1.25), (2, 1.5)

: c Price Multiplier for Acquisition Pre Competitor = Market Share Effect on Price Multiplier Pre Competitor * PriceRatio Effect on Price Multiplier for Acquisition Pre Comp

: c Desired Acquisition Price Pre Competitor = Self Dependency Fraction * Acquisition Price Pre Competitor + (1 - Self Dependency Fraction) * Normal Price Pre * Price Multiplier for Acquisition Pre Competitor

: b Flow 1 = (Desired Acquisition Price Pre Competitor - Acquisition Price Pre Competitor) / Response Delay for Price

: c Service Quality Perception Delay = 6 / 3

: s Adjustment Stock1 = 100000000

: c Desired Service Features Spending per Capita = 30

: c Desired Advertising Spending = 50000000

: c CAPEX = 200000000

: s PrePaid = 9760000

: c Total Customer PrePaid = New PrePaid + PrePaid

: s Decision PostPaid = 6840000

: c Total Customer PostPaid = New PostPaid + Contract PostPaid + Decision PostPaid

: c Total Customer = Total Customer PostPaid + Total Customer PrePaid

: s Other PostPaid = 20000000

: s PrePaid Competitor = 9760000

: c Total Customer PrePaid Competitor = New PrePaid Competitor + PrePaid Competitor

: s PostPaid Competitor = 9120000

: c Total Customer PostPaid Competitor = New PostPaid Competitor + PostPaid Competitor

: c Total Customer Competitor = Total Customer PostPaid Competitor + Total Customer PrePaid Competitor

: s Other PrePaid = 20000000

: c All Customers = Other PrePaid + Total Customer Competitor + Other PostPaid + Total Customer

: c Desired Service Quality Spending = 100000000

: c Projected Desired Cost = Desired Advertising Spending + Total Customer * Desired Service Features Spending per Capita + Desired Service Quality Spending + (1 + Total Customer / All Customers) * CAPEX

: c Acquisition Price Pre = 40

: c Contract Price = 48

: c Internal Price Pre = 40

: c Internal Price Post = 60

: c Acquisition Price Post = 60

: c Projected Revenue = Acquisition Price Pre * New PrePaid + Internal Price Pre *

PrePaid + Contract Price * Contract PostPaid + Acquisition Price Post * New PostPaid + Internal Price Post * Decision PostPaid

: c Overspending Coefficent = 0.03

: c Effective Service Quality Spending = IF Projected Desired Cost ¿ Projected Revenue * (1 + Overspending Coefficent) THEN Desired Service Quality Spending * ( (Projected Revenue * (1 + Overspending Coefficent)) / Projected Desired Cost) ELSE Desired Service Quality Spending

: b Adjustment Flow7 = (Effective Service Quality Spending - Adjustment Stock1) / Service Quality Perception Delay

: s Adjustment Stock2 = 100000000

: b Adjustment Flow8 = (Adjustment Stock1 - Adjustment Stock2) / Service Quality Perception Delay

: c Service Quality Perception Delay Competitor = 6 / 3

: s Service Quality Spending Competitor = 100000000

: s Adjustment Stock7 = 100000000

: b Adjustment Flow20 = (Service Quality Spending Competitor - Adjustment Stock7) / Service Quality Perception Delay Competitor

: s Adjustment Stock8 = 100000000

: b Adjustment Flow21 = (Adjustment Stock7 - Adjustment Stock8) / Service Quality Perception Delay Competitor

: s Adjustment Stock 5 = 30

: c Service Features Perception Delay = 2 / 2

: c Effective Service Features Spending per Capita = IF Projected Desired Cost ¿ Projected Revenue * (1 + Overspending Coefficent) THEN Desired Service Features Spending per Capita * ( (Projected Revenue * (1 + Overspending Coefficent)) / Projected Desired Cost) ELSE Desired Service Features Spending per Capita

: b Adjustment Flow 5 = (Effective Service Features Spending per Capita - Adjustment Stock 5) / Service Features Perception Delay

: s Service Features Spending per Capita Competitor = 30

: c Service Features Perception Delay Competitor = 2 / 2

: s Adjustment Stock 8 = 30

: b Adjustment Flow6 = (Service Features Spending per Capita Competitor - Adjustment Stock 8) / Service Features Perception Delay Competitor

: c Response Delay for Investment = 4

: c Normal Advertisement Spending = 50000000

: c Normal Profit Ratio Competitor = 1

: s Avg Revenue Competitor = 1000

: s Avg Cost Competitor = 1000

: c Profit Rato Competitor = Avg Revenue Competitor / Avg Cost Competitor

: c Profit Ratio Effect on Investment Multipler = GRAPH (Profit Rato Competitor / Normal Profit Ratio Competitor) (0, 0.4), (0.333, 0.6), (0.667, 0.8), (1, 1), (1.333, 1.5), (1.667, 1.75), (2, 1.85), (2.333, 1.9), (2.667, 1.95), (3, 2)

: c Normal Market Share Competitor = 0.5

: c Market Share Competitor = Total Customer Competitor / (Total Customer + Total Customer Competitor)

: c Market Share Effect onInvestment = GRAPH (Market Share Competitor / Normal Market Share Competitor) (0, 2), (0.5, 1.5), (1, 1), (1.5, 0.9), (2, 0.75)

: c Investment Multiplier = Market Share Effect onInvestment * Profit Ratio Effect on Investment Multipler

: c Desired Advertising Spending Competitor = Normal Advertisement Spending * Investment Multiplier

: c Normal Service Features Spending Per Capita = 30

: c Desired Service Features Spending per Capita Competitor = Normal Service Features Spending Per Capita * Investment Multiplier

: c Normal Service Quality Spending = 100000000

: c Desired Service Quality Spending Competitor = Normal Service Quality Spending * Investment Multiplier

: c Projected Desired Cost Competitor = (Desired Advertising Spending Competitor + Total Customer Competitor * Desired Service Features Spending per Capita Competitor + Desired Service Quality Spending Competitor + (1 + Total Customer Competitor / All Customers) * CAPEX)

: s Internal Price Post Competitor = 60

: s Avg Internal Price Post Competitor = 60

: s Avg Internal Price Post = 60

: c PriceRatio Effect on Price Multiplier Internal Post Competitor = GRAPH (Avg Internal Price Post Competitor / MIN (80, Avg Internal Price Post)) (0, 2), (0.333, 1.667), (0.667, 1.25), (1, 1), (1.333, 0.8), (1.667, 0.6), (2, 0.5)

: c Price Multiplier for Internal Post Competitor = Market Share Effect on Price Multiplier PostCompetitor * PriceRatio Effect on Price Multiplier Internal Post Competitor

: c Desired Internal Price Post Competitor = Self Dependency Fraction * Internal Price Post Competitor + (1 - Self Dependency Fraction) * Normal Price Post * Price Multiplier for Internal Post Competitor

: s Avg Internal Price Pre = 40

: s Avg Internal Price Pre Competitor = 40

: c PriceRatio Effect on Price Multiplier for Internal Pre Competitor = GRAPH (Avg Internal Price Pre Competitor / MIN (60, Avg Internal Price Pre)) (0, 2), (0.333, 1.667), (0.667, 1.25), (1, 1), (1.333, 0.8), (1.667, 0.6), (2, 0.5)

: c Price Multiplier for Internal Pre Competitor = Market Share Effect on Price Multiplier Pre Competitor * PriceRatio Effect on Price Multiplier for Internal Pre Competitor

: s Internal Price Pre Competitor = 40

: c Desired Internal Price Pre Competitor = Self Dependency Fraction * Internal Price Pre Competitor + (1 - Self Dependency Fraction) * Normal Price Pre * Price Multiplier for Internal Pre Competitor

: c Projected Revenue Competitor = Desired Acquisition Price Pre Competitor * New PrePaid Competitor + Desired Internal Price Pre Competitor * PrePaid Competitor + Desired Acquisition Price Post Competitor * New PostPaid Competitor + Desired Internal Price Post Competitor * PostPaid Competitor

: c Effective Advertising Spending Competitor = IF Projected Desired Cost Competitor ¿ Projected Revenue Competitor * (1 + Overspending Coefficent) THEN Desired Advertising Spending Competitor * ( (Projected Revenue Competitor * (1 + Overspending Coefficent)) / Projected Desired Cost Competitor) ELSE Desired Advertising Spending Competitor

: s Advertising Spending Competitor = 50000000

: b Flow 5 = (Effective Advertising Spending Competitor - Advertising Spending Competitor) / Response Delay for Investment

: c Smoothing Delay 15 = 3

: b Adjustment Flow 25 = (Acquisition Price Post - Avg Acquisition Price Post) / Smoothing Delay 15

: c Smoothing Delay 13 = 3

: b Adjustment Flow 26 = (Acquisition Price Post Competitor - Avg Acquisition Price Post Competitor) / Smoothing Delay 13

: c Smoothing Delay 11 = 3

: b Adjustment Flow 21 = (Acquisition Price Pre - Avg Acquisition Price Pre) / Smoothing Delay 11

: c Smoothing Delay 9 = 3

: b Adjustment Flow 22 = (Acquisition Price Pre Competitor - Avg Acquisition Price Pre Competitor) / Smoothing Delay 9

: s Avg Cost = 1000

: c Effective Advertising Spending = IF Projected Desired Cost ¿ Projected Revenue * (1 + Overspending Coefficent) THEN Desired Advertising Spending * ( (Projected Revenue * (1 + Overspending Coefficent)) / Projected Desired Cost) ELSE Desired Advertising Spending

: f Cost = (Effective Advertising Spending + Total Customer * Effective Service Features Spending per Capita + Effective Service Quality Spending + (1 + Total Customer / All Customers) * CAPEX) / 1000000

: c Smoothing Delay 2 = 3

: b Adjustment Flow 14 = (Cost - Avg Cost) / Smoothing Delay 2

: f Cost Competitor = (Advertising Spending Competitor + Total Customer Competitor * Service Features Spending per Capita Competitor + Service Quality Spending Competitor + (1 + Total Customer Competitor / All Customers) * CAPEX) / 1000000

: c Smoothing Delay 3 = 3

: b Adjustment Flow 15 = (Cost Competitor - Avg Cost Competitor) / Smoothing Delay 3

: c Smoothing Delay 19 = 3

: b Adjustment Flow 29 = (Internal Price Post - Avg Internal Price Post) / Smoothing Delay 19

: c Smoothing Delay 17 = 3

: b Adjustment Flow 30 = (Internal Price Post Competitor - Avg Internal Price Post Competitor) / Smoothing Delay 17

: c Smoothing Delay 5 = 3

: b Adjustment Flow 17 = (Internal Price Pre - Avg Internal Price Pre) / Smoothing Delay 5

: c Smoothing Delay 6 = 3

: b Adjustment Flow 18 = (Internal Price Pre Competitor - Avg Internal Price Pre Competitor) / Smoothing Delay 6

: c Smoothing Delay 18 = 3

: b Adjustment Flow 31 = (Other PostPaid + Total Customer PostPaid - Avg Number of Customer Post) / Smoothing Delay 18

: c Smoothing Delay 8 = 3

: b Adjustment Flow 20 = (Total Customer PrePaid + Other PrePaid - Avg Number of Customer Pre) / Smoothing Delay 8

: c Smoothing Delay 7 = 3

: b Adjustment Flow 19 = (Total Customer PrePaid Competitor - Avg Number of Customer Pre Competitor) / Smoothing Delay 7

: c Smoothing Delay 20 = 3

: b Adjustment Flow 32 = (Total Customer PostPaid Competitor - Avg Number of Customer Post Competitor) / Smoothing Delay 20

: c Smoothing Delay 1 = 3

: f Revenue = (PrePaid * Internal Price Pre + Decision PostPaid * Internal Price Post + Fixed Revenue) / 1000000

: s Avg Revenue = 1000

: b Adjustment Flow 13 = (Revenue - Avg Revenue) / Smoothing Delay 1

: f Revenue Competitor = (Internal Price Pre Competitor * PrePaid Competitor + Internal Price Post Competitor * PostPaid Competitor + Fixed Revenue Competitor)

/ 1000000

: c Smoothing Delay 4 = 3

: b Adjustment Flow 16 = (Revenue Competitor - Avg Revenue Competitor) / Smoothing Delay 4

: f Maturation Post = CONVEYOR OUTFLOW

: f Contract Termination = CONVEYOR OUTFLOW

: c Normal Port Out toOther Post Fr = 0.0008

: c Price Effect on Port Out toOther Post = GRAPH (Internal Price Post / Normal Price Post) (0, 0.001), (0.2, 0.2), (0.4, 0.4), (0.6, 0.6), (0.8, 0.8), (1, 1), (1.2, 5), (1.4, 15), (1.6, 30), (1.8, 48), (2, 50), (2.2, 1000)

: s Perceived Service Features Spending per Capita = 30

: c Service Features Effect on Port Out toOther Post = GRAPH (Normal Service Features Spending Per Capita / Perceived Service Features Spending per Capita) (0, 0.001), (1, 1), (2, 50), (3, 200), (4, 800), (5, 1800), (6, 1990), (7, 2000)

: s Perceived Service Quality Spending = 100000000

: c Service Quality Effect on Port Out toOther Post = GRAPH (Normal Service Quality Spending / Perceived Service Quality Spending) (0, 0.001), (1, 1), (2, 50), (3, 200), (4, 800), (5, 1800), (6, 1990), (7, 2000)

: f Port Out to Other Post = Decision PostPaid * Normal Port Out toOther Post Fr * Price Effect on Port Out toOther Post * Service Features Effect on Port Out toOther Post * Service Quality Effect on Port Out toOther Post

: c Normal Contract Fr = 1 / 36

: c Effect of Price Ratio on Contract Post = GRAPH (Contract Price / Internal Price Post) (0, 2), (0.2, 1.8), (0.4, 1.6), (0.6, 1.3), (0.8, 1), (1, 0.001)

: f Post Contract Rate = Decision PostPaid * Normal Contract Fr * Effect of Price Ratio on Contract Post

: c Normal Port in Post Fr Competitor = 0.008

: c Service Quality Effect on Port in Post Competitor = GRAPH (Perceived Service Quality Spending / Normal Service Quality Spending) (0, 2), (0.2, 1.9), (0.4, 1.7), (0.6, 1.5), (0.8, 1.25), (1, 1), (1.2, 0.75), (1.4, 0.5), (1.6, 0.3), (1.8, 0.1), (2, 0.001)

: c Service Features Effect on Port in Post Competitor = GRAPH (Perceived Service

Features Spending per Capita / Normal Service Features Spending Per Capita) (0, 3), (0.333, 1.8), (0.667, 1.3), (1, 1), (1.333, 0.85), (1.667, 0.667), (2, 0.5), (2.333, 0.333), (2.667, 0.15), (3, 0.001)

: c Price Effect on Port in Post Competitor = GRAPH (Internal Price Post / Acquisition Price Post Competitor) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.7), (1, 1), (1.2, 1.25), (1.4, 1.5), (1.6, 1.7), (1.8, 1.9), (2, 2)

: s Perceived Advertising Spending Competitor = 50000000

: c Advertisement Effect on Port in Post Competitor = GRAPH (Perceived Advertising Spending Competitor / Normal Advertisement Spending) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.75), (1, 1), (1.2, 1.2)

: f Port in Post Competitor = Decision PostPaid * Normal Port in Post Fr Competitor * Service Quality Effect on Port in Post Competitor * Service Features Effect on Port in Post Competitor * Price Effect on Port in Post Competitor * Advertisement Effect on Port in Post Competitor

: b Flow 4 = (Desired Internal Price Post Competitor - Internal Price Post Competitor) / Response Delay for Price

: b Flow 2 = (Desired Internal Price Pre Competitor - Internal Price Pre Competitor) / Response Delay for Price

: c Normal Port Out toOther Post Fr Competitor = 0.0006

: f Maturation Post Competitor = CONVEYOR OUTFLOW

: c Price Effect on Port Out toOther Post Competitor = GRAPH (Internal Price Post Competitor / Normal Price Post) (0, 0.001), (0.2, 0.2), (0.4, 0.4), (0.6, 0.6), (0.8, 0.8), (1, 1), (1.2, 5), (1.4, 15), (1.6, 30), (1.8, 48), (2, 50), (2.2, 1000)

: s Perceived Service Features Spending per Capita Competitor = 30

: c Service Features Effect on Port Out toOther Post Competitor = GRAPH (Normal Service Features Spending Per Capita / Perceived Service Features Spending per Capita Competitor) (0, 0.001), (1, 1), (2, 50), (3, 200), (4, 800), (5, 1800), (6, 1990), (7, 2000)

: s Perceived Service Quality Spending Competitor = 100000000

: c Service Quality Effect on Port Out toOther Post Competitor = GRAPH (Normal Service Quality Spending / Perceived Service Quality Spending Competitor) (0, 0.001), (1, 1), (2, 50), (3, 200), (4, 800), (5, 1800), (6, 1990), (7, 2000)

: f Port Out to Other Post Competitor = PostPaid Competitor * Normal Port Out toOther Post Fr Competitor * Price Effect on Port Out toOther Post Competitor * Service Features Effect on Port Out toOther Post Competitor * Service Quality Effect on Port Out toOther Post Competitor

: f Maturation Pre = CONVEYOR OUTFLOW

: c Normal Port Out toOther Pre Fr = 0.0001

: c Price Effect on Port Out toOther Pre = GRAPH (Internal Price Pre / Normal Price Pre) (0, 0.001), (0.2, 0.2), (0.4, 0.4), (0.6, 0.6), (0.8, 0.8), (1, 1), (1.2, 5), (1.4, 15), (1.6, 30), (1.8, 48), (2, 50), (2.2, 1000)

: c Service Features Effect on Port Out toOther Pre = GRAPH (Normal Service Features Spending Per Capita / Perceived Service Features Spending per Capita) (0, 0.001), (1, 1), (2, 50), (3, 200), (4, 800), (5, 1800), (6, 1990), (7, 2000)

: c Service Quality Effect on Port Out toOther Pre = GRAPH (Normal Service Quality Spending / Perceived Service Quality Spending) (0, 0.001), (1, 1), (2, 50), (3, 200), (4, 800), (5, 1800), (6, 1990), (7, 2000)

: f Port Out to Other Pre = PrePaid * Normal Port Out toOther Pre Fr * Price Effect on Port Out toOther Pre * Service Features Effect on Port Out toOther Pre * Service Quality Effect on Port Out toOther Pre

: f Maturation Pre Competitor = CONVEYOR OUTFLOW

: c Price Effect on Port Out toOther Pre Competitor = GRAPH (Internal Price Pre Competitor / Normal Price Pre) (0, 0.001), (0.2, 0.2), (0.4, 0.4), (0.6, 0.6), (0.8, 0.8), (1, 1), (1.2, 5), (1.4, 15), (1.6, 30), (1.8, 48), (2, 50), (2.2, 1000)

: c Service Features Effect on Port Out toOther Pre Competitor = GRAPH (Normal Service Features Spending Per Capita / Perceived Service Features Spending per Capita Competitor) (0, 0.001), (1, 1), (2, 50), (3, 200), (4, 800), (5, 1800), (6, 1990), (7, 2000)

: c Service Quality Effect on Port Out toOther Pre Competitor = GRAPH (Normal Service Quality Spending / Perceived Service Quality Spending Competitor) (0, 0.001), (1, 1), (2, 50), (3, 200), (4, 800), (5, 1800), (6, 1990), (7, 2000)

: f Port Out to Other Pre Competitor = PrePaid Competitor * Normal Port Out toOther Pre Fr * Price Effect on Port Out toOther Pre Competitor * Service Features Effect on Port Out toOther Pre Competitor * Service Quality Effect on Port Out toOther Pre Competitor

: f Customer Entry PrePaid = 20000

: c Normal Pre2Post Market Fr = 0.0005

: f Other Pre2Post = Other PrePaid * Normal Pre2Post Market Fr

: f Customer Entry PostPaid = 10000

: c Normal Port in From Other Post Fr = 0.00025

: c Price Effect on Port in From Other Post = GRAPH (Acquisition Price Post / Normal Price Post) (0, 2), (0.2, 1.9), (0.4, 1.7), (0.6, 1.5), (0.8, 1.25), (1, 1), (1.2, 0.75), (1.4, 0.5), (1.6, 0.3), (1.8, 0.1), (2, 0.001)

: s Perceived Advertising Spending = 50000000

: c Advertisement Effect on Port in From Other Post = GRAPH (Perceived Advertising Spending / Normal Advertisement Spending) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.75), (1, 1), (1.2, 1.2)

: f Port in From Other Post = Other PostPaid * Normal Port in From Other Post Fr * Price Effect on Port in From Other Post * Advertisement Effect on Port in From Other Post

: c Price Effect on Port in From Other Post Competitor = GRAPH (Acquisition Price Post Competitor / Normal Price Post) (0, 2), (0.2, 1.9), (0.4, 1.7), (0.6, 1.5), (0.8, 1.25), (1, 1), (1.2, 0.75), (1.4, 0.5), (1.6, 0.3), (1.8, 0.1), (2, 0.001)

: c Advertisement Effect on Port in From Other Post Competitor = GRAPH (Perceived Advertising Spending Competitor / Normal Advertisement Spending) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.75), (1, 1), (1.2, 1.2)

: f Port in From Other Post Competitor = Other PostPaid * Normal Port in From Other Post Fr * Price Effect on Port in From Other Post Competitor * Advertisement Effect on Port in From Other Post Competitor

: c Normal Port in From Other Pre Fr = 5e - 05

: c Price Effect on Port in From Other Pre = GRAPH (Acquisition Price Pre / Normal Price Pre) (0, 3), (0.2, 2.9), (0.4, 2.75), (0.6, 2.3), (0.8, 1.75), (1, 1), (1.2, 0.5), (1.4, 0.3), (1.6, 0.2), (1.8, 0.1), (2, 0.001)

: c Advertisement Effect on Port in From Other Pre = GRAPH (Perceived Advertising Spending / Normal Advertisement Spending) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.75), (1, 1), (1.2, 1.2)

: f Port in From Other Pre = Other PrePaid * Normal Port in From Other Pre Fr * Price Effect on Port in From Other Pre * Advertisement Effect on Port in From Other Pre

: c Price Effect on Port in From Other Pre Competitor = GRAPH (Acquisition Price Pre Competitor / Normal Price Pre) (0, 3), (0.2, 2.9), (0.4, 2.75), (0.6, 2.3), (0.8, 1.75), (1, 1), (1.2, 0.5), (1.4, 0.3), (1.6, 0.2), (1.8, 0.1), (2, 0.001)

: c Advertisement Effect on Port in From Other Pre Competitor = GRAPH (Perceived Advertising Spending Competitor / Normal Advertisement Spending) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.75), (1, 1), (1.2, 1.2)

: f Port in From Other Pre Competitor = Other PrePaid * Normal Port in From Other Pre Fr * Price Effect on Port in From Other Pre Competitor * Advertisement Effect on Port in From Other Pre Competitor

: c Advertising Perception Delay = 0.25

: b Adjustment Flow1 = (Effective Advertising Spending - Perceived Advertising Spending) / Advertising Perception Delay

: c Advertising Perception Delay Competitor = 0.25

: b Adjustment Flow2 = (Advertising Spending Competitor - Perceived Advertising Spending Competitor) / Advertising Perception Delay Competitor

: b Adjustment Flow3 = (Adjustment Stock 5 - Perceived Service Features Spending per Capita) / Service Features Perception Delay

: b Adjustment Flow4 = (Adjustment Stock 8 - Perceived Service Features Spending per Capita Competitor) / Service Features Perception Delay Competitor

: b Adjustment Flow9 = (Adjustment Stock2 - Perceived Service Quality Spending) / Service Quality Perception Delay

: b Adjustment Flow22 = (Adjustment Stock8 - Perceived Service Quality Spending Competitor) / Service Quality Perception Delay Competitor

: c Normal Port in Post Fr = 0.006

: c Service Features Effect on Port in Post = GRAPH (Perceived Service Features

Spending per Capita Competitor / Normal Service Features Spending Per Capita) (0, 3), (0.333, 1.8), (0.667, 1.3), (1, 1), (1.333, 0.85), (1.667, 0.667), (2, 0.5), (2.333, 0.333), (2.667, 0.15), (3, 0.001)

: c Service Quality Effect on Port in Post = GRAPH (Perceived Service Quality Spending Competitor / Normal Service Quality Spending) (0, 2), (0.2, 1.9), (0.4, 1.7), (0.6, 1.5), (0.8, 1.25), (1, 1), (1.2, 0.75), (1.4, 0.5), (1.6, 0.3), (1.8, 0.1), (2, 0.001)

: c Price Effect on Port in Post = GRAPH (Internal Price Post Competitor / Acquisition Price Post) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.7), (1, 1), (1.2, 1.25), (1.4, 1.5), (1.6, 1.7), (1.8, 1.9), (2, 2)

: c Advertisement Effect on Port in Post = GRAPH (Perceived Advertising Spending / Normal Advertisement Spending) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.75), (1, 1), (1.2, 1.2)

: f Port in Post = PostPaid Competitor * Normal Port in Post Fr * Service Features Effect on Port in Post * Service Quality Effect on Port in Post * Price Effect on Port in Post * Advertisement Effect on Port in Post

: c Normal Pre2Post Fr = 0.001

: c Price Effect on Pre2Post = GRAPH ( (Acquisition Price Post / Normal Price Post) / (Internal Price Pre / Normal Price Pre)) (0, 2), (0.2, 1.9), (0.4, 1.7), (0.6, 1.5), (0.8, 1.25), (1, 1), (1.2, 0.75), (1.4, 0.5), (1.6, 0.3), (1.8, 0.1), (2, 0.001)

: f Pre2Post = PrePaid * Normal Pre2Post Fr * Price Effect on Pre2Post

: c Normal Port in Pre Fr = 0.001

: c Service Features Effect on Port in Pre Competitor = GRAPH (Perceived Service Features Spending per Capita / Normal Service Features Spending Per Capita) (0, 4), (0.2, 3), (0.4, 2.3), (0.6, 1.5), (0.8, 1.25), (1, 1), (1.2, 0.75), (1.4, 0.5), (1.6, 0.3), (1.8, 0.1), (2, 0.001)

: c Service Quality Effect on Port in Pre Competitor = GRAPH (Perceived Service Quality Spending / Normal Service Quality Spending) (0, 1.5), (0.333, 1.3), (0.667, 1.15), (1, 1), (1.333, 0.85), (1.667, 0.667), (2, 0.5), (2.333, 0.333), (2.667, 0.15), (3, 0.001)

: c Price Effect on Port in Pre Competitor = GRAPH (Internal Price Pre / Acquisition Price Pre Competitor) (0, 0.001), (0.2, 0.1), (0.4, 0.2), (0.6, 0.3), (0.8, 0.5), (1, 1), (1.2, 1.75), (1.4, 2.3), (1.6, 2.75), (1.8, 2.9), (2, 3)

: c Advertisement Effect on Port in Pre Competitor = GRAPH (Perceived Advertising Spending Competitor / Normal Advertisement Spending) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.75), (1, 1), (1.2, 1.2)

: f Port in Pre Competitor = PrePaid * Normal Port in Pre Fr * Service Features Effect on Port in Pre Competitor * Service Quality Effect on Port in Pre Competitor * Price Effect on Port in Pre Competitor * Advertisement Effect on Port in Pre Competitor

: c Price Effect on Pre2Post Competitor = GRAPH ( (Acquisition Price Post Competitor / Normal Price Post) / (Internal Price Pre Competitor / Normal Price Pre)) (0, 2), (0.2, 1.9), (0.4, 1.7), (0.6, 1.5), (0.8, 1.25), (1, 1), (1.2, 0.75), (1.4, 0.5), (1.6, 0.3), (1.8, 0.1), (2, 0.001)

: f Pre2Post Competitor = PrePaid Competitor * Normal Pre2Post Fr * Price Effect on Pre2Post Competitor

: c Service Features Effect on Port in Pre = GRAPH (Perceived Service Features Spending per Capita Competitor / Normal Service Features Spending Per Capita) (0, 4), (0.2, 3), (0.4, 2.3), (0.6, 1.5), (0.8, 1.25), (1, 1), (1.2, 0.75), (1.4, 0.5), (1.6, 0.3), (1.8, 0.1), (2, 0.001)

: c Service Quality Effect on Port in Pre = GRAPH (Perceived Service Quality Spending Competitor / Normal Service Quality Spending) (0, 1.5), (0.333, 1.3), (0.667, 1.15), (1, 1), (1.333, 0.85), (1.667, 0.667), (2, 0.5), (2.333, 0.333), (2.667, 0.15), (3, 0.001)

: c Price Effect on Port in Pre = GRAPH (Internal Price Pre Competitor / Acquisition Price Pre) (0, 0.001), (0.2, 0.1), (0.4, 0.2), (0.6, 0.3), (0.8, 0.5), (1, 1), (1.2, 1.75), (1.4, 2.3), (1.6, 2.75), (1.8, 2.9), (2, 3)

: c Advertisement Effect on Port in Pre = GRAPH (Perceived Advertising Spending / Normal Advertisement Spending) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.75), (1, 1), (1.2, 1.2)

: f Port in Pre = PrePaid Competitor * Normal Port in Pre Fr * Service Features Effect on Port in Pre * Service Quality Effect on Port in Pre * Price Effect on Port in Pre * Advertisement Effect on Port in Pre

: c Effective Service Features Spending per Capita Competitor = IF Projected Desired Cost Competitor ¿ Projected Revenue Competitor * (1 + Overspending Coefficent)

THEN Desired Service Features Spending per Capita Competitor * ( (Projected Revenue Competitor * (1 + Overspending Coefficent)) / Projected Desired Cost Competitor) ELSE Desired Service Features Spending per Capita Competitor

: b Flow 6 = (Effective Service Features Spending per Capita Competitor - Service Features Spending per Capita Competitor) / Response Delay for Investment

: c Effective Service Quality Spending Competitor = IF Projected Desired Cost Competitor ¿ Projected Revenue Competitor * (1 + Overspending Coefficent) THEN Desired Service Quality Spending Competitor * ( (Projected Revenue Competitor * (1 + Overspending Coefficent)) / Projected Desired Cost Competitor) ELSE Desired Service Quality Spending Competitor

: b Flow 7 = (Effective Service Quality Spending Competitor - Service Quality Spending Competitor) / Response Delay for Investment

: c Advertisement Effect on Acquisition Post = GRAPH (Perceived Advertising Spending / Normal Advertisement Spending) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.75), (1, 1), (1.2, 1.2)

: c Normal Acquisition Rate Post = 5000

: c Price Effect on Acquisition Post = GRAPH (Acquisition Price Post / Normal Price Post) (0, 2), (0.2, 1.9), (0.4, 1.7), (0.6, 1.5), (0.8, 1.25), (1, 1), (1.2, 0.75), (1.4, 0.5), (1.6, 0.3), (1.8, 0.1), (2, 0.001)

: f Acquisition Post = Normal Acquisition Rate Post * Advertisement Effect on Acquisition Post * Price Effect on Acquisition Post

: c Price Effect on Acquisition Pre = GRAPH (Acquisition Price Pre / Normal Price Pre) (0, 3), (0.2, 2.9), (0.4, 2.75), (0.6, 2.3), (0.8, 1.75), (1, 1), (1.2, 0.5), (1.4, 0.3), (1.6, 0.2), (1.8, 0.1), (2, 0.001)

: c Advertisement Effect on Acquisition Pre = GRAPH (Perceived Advertising Spending / Normal Advertisement Spending) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.75), (1, 1), (1.2, 1.2)

: c Normal Acquisition Rate Pre = 10000

: f Acquisition Pre = Normal Acquisition Rate Pre * Price Effect on Acquisition Pre * Advertisement Effect on Acquisition Pre

: f Fixed Revenue Inflow = (Acquisition Pre + Port in From Other Pre + Port in Pre)

* Acquisition Price Pre + Post Contract Rate * Contract Price + (Acquisition Post + Pre2Post + Port in Post + Port in From Other Post) * Acquisition Price Post

: c Normal Acqusition Rate Pre Competitor = 10000

: c Price Effect on Acqsition Pre Competitor = GRAPH (Acquisition Price Pre Competitor / Normal Price Pre) (0, 3), (0.2, 2.9), (0.4, 2.75), (0.6, 2.3), (0.8, 1.75), (1, 1), (1.2, 0.5), (1.4, 0.3), (1.6, 0.2), (1.8, 0.1), (2, 0.001)

: c Advertisement Effect on Acqusition Pre Competitor = GRAPH (Perceived Advertising Spending Competitor / Normal Advertisement Spending) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.75), (1, 1), (1.2, 1.2)

: f Acqusition Pre Competitor = Normal Acqusition Rate Pre Competitor * Price Effect on Acqsition Pre Competitor * Advertisement Effect on Acqusition Pre Competitor

: c Price Effect on Acqusition Post Competitor = GRAPH (Acquisition Price Post Competitor / Normal Price Post) (0, 2), (0.2, 1.9), (0.4, 1.7), (0.6, 1.5), (0.8, 1.25), (1, 1), (1.2, 0.75), (1.4, 0.5), (1.6, 0.3), (1.8, 0.1), (2, 0.001)

: c Normal Acqusition Rate Post Competitor = 5000

: c Advertisement Effect on Acqusition Post Competitor = GRAPH (Perceived Advertising Spending Competitor / Normal Advertisement Spending) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.75), (1, 1), (1.2, 1.2)

: f Acqusition Post Competitor = Normal Acqusition Rate Post Competitor * Price Effect on Acqusition Post Competitor * Advertisement Effect on Acqusition Post Competitor

: f Fixed Revenue Inflow Competitor = (Acqusition Pre Competitor + Port in From Other Pre Competitor + Port in Pre Competitor) * Acquisition Price Pre Competitor + (Acqusition Post Competitor + Pre2Post Competitor + Port in Post Competitor + Port in From Other Post Competitor) * Acquisition Price Post Competitor

: s Profit = 0

: s Profit Competitor = 0

: f Fixed Revenue Outflow = CONVEYOR OUTFLOW

: f Fixed Revenue Outflow Competitor = CONVEYOR OUTFLOW

: c Market Cap = (Total Customer PostPaid * 100) / All Customers

: c Timer = TIME

RUNTIME EQUATIONS

:

: s Acquisition Price Post Competitor (t) = Acquisition Price Post Competitor (t - dt) + (Flow 3) * dt

: s Avg Number of Customer Post (t) = Avg Number of Customer Post (t - dt) + (Adjustment Flow 31) * dt

: s Avg Number of Customer Post Competitor (t) = Avg Number of Customer Post Competitor (t - dt) + (Adjustment Flow 32) * dt

: s Avg Acquisition Price Post Competitor (t) = Avg Acquisition Price Post Competitor (t - dt) + (Adjustment Flow 26) * dt

: s Avg Acquisition Price Post (t) = Avg Acquisition Price Post (t - dt) + (Adjustment Flow 25) * dt

: s Acquisition Price Pre Competitor (t) = Acquisition Price Pre Competitor (t - dt) + (Flow 1) * dt

: s Avg Acquisition Price Pre Competitor (t) = Avg Acquisition Price Pre Competitor (t - dt) + (Adjustment Flow 22) * dt

: s Avg Acquisition Price Pre (t) = Avg Acquisition Price Pre (t - dt) + (Adjustment Flow 21) * dt

: s Avg Number of Customer Pre (t) = Avg Number of Customer Pre (t - dt) + (Adjustment Flow 20) * dt

: s Avg Number of Customer Pre Competitor (t) = Avg Number of Customer Pre Competitor (t - dt) + (Adjustment Flow 19) * dt

: s Adjustment Stock1 (t) = Adjustment Stock1 (t - dt) + (Adjustment Flow7) * dt

: s PrePaid (t) = PrePaid (t - dt) + (Maturation Pre - Pre2Post - Port Out to Other Pre - Port in Pre Competitor) * dt

: s Decision PostPaid (t) = Decision PostPaid (t - dt) + (Maturation Post + Contract Termination - Port Out to Other Post - Post Contract Rate - Port in Post Competitor) * dt

: s Other PostPaid (t) = Other PostPaid (t - dt) + (Port Out to Other Post + Port

Out to Other Post Competitor + Other Pre2Post + Customer Entry PostPaid - Port in From Other Post - Port in From Other Post Competitor) * dt

: s PrePaid Competitor (t) = PrePaid Competitor (t - dt) + (Maturation Pre Competitor - Pre2Post Competitor - Port Out to Other Pre Competitor - Port in Pre) * dt

: s PostPaid Competitor (t) = PostPaid Competitor (t - dt) + (Maturation Post Competitor - Port Out to Other Post Competitor - Port in Post) * dt

: s Other PrePaid (t) = Other PrePaid (t - dt) + (Port Out to Other Pre + Port Out to Other Pre Competitor + Customer Entry PrePaid - Other Pre2Post - Port in From Other Pre - Port in From Other Pre Competitor) * dt

: s Adjustment Stock2 (t) = Adjustment Stock2 (t - dt) + (Adjustment Flow8) * dt

: s Service Quality Spending Competitor (t) = Service Quality Spending Competitor (t - dt) + (Flow 7) * dt

: s Adjustment Stock7 (t) = Adjustment Stock7 (t - dt) + (Adjustment Flow20) * dt

: s Adjustment Stock8 (t) = Adjustment Stock8 (t - dt) + (Adjustment Flow21) * dt

: s Adjustment Stock 5 (t) = Adjustment Stock 5 (t - dt) + (Adjustment Flow 5) * dt

: s Service Features Spending per Capita Competitor (t) = Service Features Spending per Capita Competitor (t - dt) + (Flow 6) * dt

: s Adjustment Stock 8 (t) = Adjustment Stock 8 (t - dt) + (Adjustment Flow6) * dt

: s Avg Revenue Competitor (t) = Avg Revenue Competitor (t - dt) + (Adjustment Flow 16) * dt

: s Avg Cost Competitor (t) = Avg Cost Competitor (t - dt) + (Adjustment Flow 15) * dt

: s Internal Price Post Competitor (t) = Internal Price Post Competitor (t - dt) + (Flow 4) * dt

: s Avg Internal Price Post Competitor (t) = Avg Internal Price Post Competitor (t - dt) + (Adjustment Flow 30) * dt

: s Avg Internal Price Post (t) = Avg Internal Price Post (t - dt) + (Adjustment Flow 29) * dt

: s Avg Internal Price Pre (t) = Avg Internal Price Pre (t - dt) + (Adjustment Flow 17) * dt

: s Avg Internal Price Pre Competitor (t) = Avg Internal Price Pre Competitor (t -

dt) + (Adjustment Flow 18) * dt

: s Internal Price Pre Competitor (t) = Internal Price Pre Competitor (t - dt) + (Flow 2) * dt

: s Advertising Spending Competitor (t) = Advertising Spending Competitor (t - dt) + (Flow 5) * dt

: s Avg Cost (t) = Avg Cost (t - dt) + (Adjustment Flow 14) * dt

: s Avg Revenue (t) = Avg Revenue (t - dt) + (Adjustment Flow 13) * dt

: s Perceived Service Features Spending per Capita (t) = Perceived Service Features Spending per Capita (t - dt) + (Adjustment Flow3) * dt

: s Perceived Service Quality Spending (t) = Perceived Service Quality Spending (t - dt) + (Adjustment Flow9) * dt

: s Perceived Advertising Spending Competitor (t) = Perceived Advertising Spending Competitor (t - dt) + (Adjustment Flow2) * dt

: s Perceived Service Features Spending per Capita Competitor (t) = Perceived Service Features Spending per Capita Competitor (t - dt) + (Adjustment Flow4) * dt

: s Perceived Service Quality Spending Competitor (t) = Perceived Service Quality Spending Competitor (t - dt) + (Adjustment Flow22) * dt

: s Perceived Advertising Spending (t) = Perceived Advertising Spending (t - dt) + (Adjustment Flow1) * dt

: s Profit (t) = Profit (t - dt) + (Revenue - Cost) * dt

: s Profit Competitor (t) = Profit Competitor (t - dt) + (Revenue Competitor - Cost Competitor) * dt

: l Contract PostPaid (t) = Contract PostPaid (t - dt) + (Post Contract Rate - Contract Termination) * dt

: l Fixed Revenue (t) = Fixed Revenue (t - dt) + (Fixed Revenue Inflow - Fixed Revenue Outflow) * dt

: l Fixed Revenue Competitor (t) = Fixed Revenue Competitor (t - dt) + (Fixed Revenue Inflow Competitor - Fixed Revenue Outflow Competitor) * dt

: l New PostPaid Competitor (t) = New PostPaid Competitor (t - dt) + (Pre2Post Competitor + Port in From Other Post Competitor + Port in Post Competitor + Acqusition Post Competitor - Maturation Post Competitor) * dt

: l New PrePaid Competitor (t) = New PrePaid Competitor (t - dt) + (Port in From Other Pre Competitor + Port in Pre Competitor + Acqusition Pre Competitor - Maturation Pre Competitor) * dt

: l New PostPaid (t) = New PostPaid (t - dt) + (Pre2Post + Port in From Other Post + Port in Post + Acquisition Post - Maturation Post) * dt

: l New PrePaid (t) = New PrePaid (t - dt) + (Port in From Other Pre + Port in Pre + Acquisition Pre - Maturation Pre) * dt

: c Market Share Effect on Price Multiplier PostCompetitor = GRAPH (Avg Number of Customer Post Competitor * 3 / Avg Number of Customer Post) (0, 0.666), (0.5, 0.8), (1, 1), (1.5, 1.25), (2, 1.5)

: c PriceRatio Effect on Price Multiplier Acquisition Post Competitor = GRAPH (Avg Acquisition Price Post Competitor / MIN (80, Avg Acquisition Price Post)) (0, 2), (0.333, 1.667), (0.667, 1.25), (1, 1), (1.333, 0.8), (1.667, 0.6), (2, 0.5)

: c Price Multiplier for Acquisition Post Competitor = Market Share Effect on Price Multiplier PostCompetitor * PriceRatio Effect on Price Multiplier Acquisition Post Competitor

: c Desired Acquisition Price Post Competitor = Self Dependency Fraction * Acquisition Price Post Competitor + (1 - Self Dependency Fraction) * Normal Price Post * Price Multiplier for Acquisition Post Competitor

: b Flow 3 = (Desired Acquisition Price Post Competitor - Acquisition Price Post Competitor) / Response Delay for Price

: c PriceRatio Effect on Price Multiplier for Acquisition Pre Comp = GRAPH (Avg Acquisition Price Pre Competitor / MIN (60, Avg Acquisition Price Pre)) (0, 2), (0.333, 1.667), (0.667, 1.25), (1, 1), (1.333, 0.8), (1.667, 0.6), (2, 0.5)

: c Market Share Effect on Price Multiplier Pre Competitor = GRAPH (Avg Number of Customer Pre Competitor * 3 / Avg Number of Customer Pre) (0, 0.666), (0.5, 0.8), (1, 1), (1.5, 1.25), (2, 1.5)

: c Price Multiplier for Acquisition Pre Competitor = Market Share Effect on Price Multiplier Pre Competitor * PriceRatio Effect on Price Multiplier for Acquisition Pre Comp

: c Desired Acquisition Price Pre Competitor = Self Dependency Fraction * Acquisition Price Pre Competitor + (1 - Self Dependency Fraction) * Normal Price Pre * Price Multiplier for Acquisition Pre Competitor

: b Flow 1 = (Desired Acquisition Price Pre Competitor - Acquisition Price Pre Competitor) / Response Delay for Price

: c Total Customer PrePaid = New PrePaid + PrePaid

: c Total Customer PostPaid = New PostPaid + Contract PostPaid + Decision PostPaid

: c Total Customer = Total Customer PostPaid + Total Customer PrePaid

: c Total Customer PrePaid Competitor = New PrePaid Competitor + PrePaid Competitor

: c Total Customer PostPaid Competitor = New PostPaid Competitor + PostPaid Competitor

: c Total Customer Competitor = Total Customer PostPaid Competitor + Total Customer PrePaid Competitor

: c All Customers = Other PrePaid + Total Customer Competitor + Other PostPaid + Total Customer

: c Projected Desired Cost = Desired Advertising Spending + Total Customer * Desired Service Features Spending per Capita + Desired Service Quality Spending + (1 + Total Customer / All Customers) * CAPEX

: c Projected Revenue = Acquisition Price Pre * New PrePaid + Internal Price Pre * PrePaid + Contract Price * Contract PostPaid + Acquisition Price Post * New PostPaid + Internal Price Post * Decision PostPaid

: c Effective Service Quality Spending = IF Projected Desired Cost ¿ Projected Revenue * (1 + Overspending Coefficent) THEN Desired Service Quality Spending * ( (Projected Revenue * (1 + Overspending Coefficent)) / Projected Desired Cost) ELSE Desired Service Quality Spending

: b Adjustment Flow7 = (Effective Service Quality Spending - Adjustment Stock1) / Service Quality Perception Delay

: b Adjustment Flow8 = (Adjustment Stock1 - Adjustment Stock2) / Service Quality Perception Delay

: b Adjustment Flow20 = (Service Quality Spending Competitor - Adjustment Stock7)

/ Service Quality Perception Delay Competitor

: b Adjustment Flow21 = (Adjustment Stock7 - Adjustment Stock8) / Service Quality Perception Delay Competitor

: c Effective Service Features Spending per Capita = IF Projected Desired Cost ¿ Projected Revenue * (1 + Overspending Coefficent) THEN Desired Service Features Spending per Capita * ( (Projected Revenue * (1 + Overspending Coefficent)) / Projected Desired Cost) ELSE Desired Service Features Spending per Capita

: b Adjustment Flow 5 = (Effective Service Features Spending per Capita - Adjustment Stock 5) / Service Features Perception Delay

: b Adjustment Flow6 = (Service Features Spending per Capita Competitor - Adjustment Stock 8) / Service Features Perception Delay Competitor

: c Profit Rato Competitor = Avg Revenue Competitor / Avg Cost Competitor

: c Profit Ratio Effect on Investment Multipler = GRAPH (Profit Rato Competitor / Normal Profit Ratio Competitor) (0, 0.4), (0.333, 0.6), (0.667, 0.8), (1, 1), (1.333, 1.5), (1.667, 1.75), (2, 1.85), (2.333, 1.9), (2.667, 1.95), (3, 2)

: c Market Share Competitor = Total Customer Competitor / (Total Customer + Total Customer Competitor)

: c Market Share Effect onInvestment = GRAPH (Market Share Competitor / Normal Market Share Competitor) (0, 2), (0.5, 1.5), (1, 1), (1.5, 0.9), (2, 0.75)

: c Investment Multiplier = Market Share Effect onInvestment * Profit Ratio Effect on Investment Multipler

: c Desired Advertising Spending Competitor = Normal Advertisement Spending * Investment Multiplier

: c Desired Service Features Spending per Capita Competitor = Normal Service Features Spending Per Capita * Investment Multiplier

: c Desired Service Quality Spending Competitor = Normal Service Quality Spending * Investment Multiplier

: c Projected Desired Cost Competitor = (Desired Advertising Spending Competitor + Total Customer Competitor * Desired Service Features Spending per Capita Competitor + Desired Service Quality Spending Competitor + (1 + Total Customer Competitor / All Customers) * CAPEX)

: c PriceRatio Effect on Price Multiplier Internal Post Competitor = GRAPH (Avg Internal Price Post Competitor / MIN (80, Avg Internal Price Post)) (0, 2), (0.333, 1.667), (0.667, 1.25), (1, 1), (1.333, 0.8), (1.667, 0.6), (2, 0.5)

: c Price Multiplier for Internal Post Competitor = Market Share Effect on Price Multiplier PostCompetitor * PriceRatio Effect on Price Multiplier Internal Post Competitor

: c Desired Internal Price Post Competitor = Self Dependency Fraction * Internal Price Post Competitor + (1 - Self Dependency Fraction) * Normal Price Post * Price Multiplier for Internal Post Competitor

: c PriceRatio Effect on Price Multiplier for Internal Pre Competitor = GRAPH (Avg Internal Price Pre Competitor / MIN (60, Avg Internal Price Pre)) (0, 2), (0.333, 1.667), (0.667, 1.25), (1, 1), (1.333, 0.8), (1.667, 0.6), (2, 0.5)

: c Price Multiplier for Internal Pre Competitor = Market Share Effect on Price Multiplier Pre Competitor * PriceRatio Effect on Price Multiplier for Internal Pre Competitor

: c Desired Internal Price Pre Competitor = Self Dependency Fraction * Internal Price Pre Competitor + (1 - Self Dependency Fraction) * Normal Price Pre * Price Multiplier for Internal Pre Competitor

: c Projected Revenue Competitor = Desired Acquisition Price Pre Competitor * New PrePaid Competitor + Desired Internal Price Pre Competitor * PrePaid Competitor + Desired Acquisition Price Post Competitor * New PostPaid Competitor + Desired Internal Price Post Competitor * PostPaid Competitor

: c Effective Advertising Spending Competitor = IF Projected Desired Cost Competitor ¿ Projected Revenue Competitor * (1 + Overspending Coefficent) THEN Desired Advertising Spending Competitor * ( (Projected Revenue Competitor * (1 + Overspending Coefficent)) / Projected Desired Cost Competitor) ELSE Desired Advertising Spending Competitor

: b Flow 5 = (Effective Advertising Spending Competitor - Advertising Spending Competitor) / Response Delay for Investment

: b Adjustment Flow 25 = (Acquisition Price Post - Avg Acquisition Price Post) / Smoothing Delay 15

: b Adjustment Flow 26 = (Acquisition Price Post Competitor - Avg Acquisition Price

Post Competitor) / Smoothing Delay 13

: b Adjustment Flow 21 = (Acquisition Price Pre - Avg Acquisition Price Pre) / Smoothing Delay 11

: b Adjustment Flow 22 = (Acquisition Price Pre Competitor - Avg Acquisition Price Pre Competitor) / Smoothing Delay 9

: c Effective Advertising Spending = IF Projected Desired Cost ¿ Projected Revenue * (1 + Overspending Coefficent) THEN Desired Advertising Spending * ( (Projected Revenue * (1 + Overspending Coefficent)) / Projected Desired Cost) ELSE Desired Advertising Spending

: f Cost = (Effective Advertising Spending + Total Customer * Effective Service Features Spending per Capita + Effective Service Quality Spending + (1 + Total Customer / All Customers) * CAPEX) / 1000000

: b Adjustment Flow 14 = (Cost - Avg Cost) / Smoothing Delay 2

: f Cost Competitor = (Advertising Spending Competitor + Total Customer Competitor * Service Features Spending per Capita Competitor + Service Quality Spending Competitor + (1 + Total Customer Competitor / All Customers) * CAPEX) / 1000000

: b Adjustment Flow 15 = (Cost Competitor - Avg Cost Competitor) / Smoothing Delay 3

: b Adjustment Flow 29 = (Internal Price Post - Avg Internal Price Post) / Smoothing Delay 19

: b Adjustment Flow 30 = (Internal Price Post Competitor - Avg Internal Price Post Competitor) / Smoothing Delay 17

: b Adjustment Flow 17 = (Internal Price Pre - Avg Internal Price Pre) / Smoothing Delay 5

: b Adjustment Flow 18 = (Internal Price Pre Competitor - Avg Internal Price Pre Competitor) / Smoothing Delay 6

: b Adjustment Flow 31 = (Other PostPaid + Total Customer PostPaid - Avg Number of Customer Post) / Smoothing Delay 18

: b Adjustment Flow 20 = (Total Customer PrePaid + Other PrePaid - Avg Number of Customer Pre) / Smoothing Delay 8

: b Adjustment Flow 19 = (Total Customer PrePaid Competitor - Avg Number of

Customer Pre Competitor) / Smoothing Delay 7

: b Adjustment Flow 32 = (Total Customer PostPaid Competitor - Avg Number of Customer Post Competitor) / Smoothing Delay 20

: f Revenue = (PrePaid * Internal Price Pre + Decision PostPaid * Internal Price Post + Fixed Revenue) / 1000000

: b Adjustment Flow 13 = (Revenue - Avg Revenue) / Smoothing Delay 1

: f Revenue Competitor = (Internal Price Pre Competitor * PrePaid Competitor + Internal Price Post Competitor * PostPaid Competitor + Fixed Revenue Competitor) / 1000000

: b Adjustment Flow 16 = (Revenue Competitor - Avg Revenue Competitor) / Smoothing Delay 4

: f Maturation Post = CONVEYOR OUTFLOW

: f Contract Termination = CONVEYOR OUTFLOW

: c Price Effect on Port Out toOther Post = GRAPH (Internal Price Post / Normal Price Post) (0, 0.001), (0.2, 0.2), (0.4, 0.4), (0.6, 0.6), (0.8, 0.8), (1, 1), (1.2, 5), (1.4, 15), (1.6, 30), (1.8, 48), (2, 50), (2.2, 1000)

: c Service Features Effect on Port Out toOther Post = GRAPH (Normal Service Features Spending Per Capita / Perceived Service Features Spending per Capita) (0, 0.001), (1, 1), (2, 50), (3, 200), (4, 800), (5, 1800), (6, 1990), (7, 2000)

: c Service Quality Effect on Port Out toOther Post = GRAPH (Normal Service Quality Spending / Perceived Service Quality Spending) (0, 0.001), (1, 1), (2, 50), (3, 200), (4, 800), (5, 1800), (6, 1990), (7, 2000)

: f Port Out to Other Post = Decision PostPaid * Normal Port Out toOther Post Fr * Price Effect on Port Out toOther Post * Service Features Effect on Port Out toOther Post * Service Quality Effect on Port Out toOther Post

: c Effect of Price Ratio on Contract Post = GRAPH (Contract Price / Internal Price Post) (0, 2), (0.2, 1.8), (0.4, 1.6), (0.6, 1.3), (0.8, 1), (1, 0.001)

: f Post Contract Rate = Decision PostPaid * Normal Contract Fr * Effect of Price Ratio on Contract Post

: c Service Quality Effect on Port in Post Competitor = GRAPH (Perceived Service Quality Spending / Normal Service Quality Spending) (0, 2), (0.2, 1.9), (0.4, 1.7), (0.6, 1.5), (0.8, 1.25), (1, 1), (1.2, 0.75), (1.4, 0.5), (1.6, 0.3), (1.8, 0.1), (2, 0.001)

: c Service Features Effect on Port in Post Competitor = GRAPH (Perceived Service Features Spending per Capita / Normal Service Features Spending Per Capita) (0, 3), (0.333, 1.8), (0.667, 1.3), (1, 1), (1.333, 0.85), (1.667, 0.667), (2, 0.5), (2.333, 0.333), (2.667, 0.15), (3, 0.001)

: c Price Effect on Port in Post Competitor = GRAPH (Internal Price Post / Acquisition Price Post Competitor) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.7), (1, 1), (1.2, 1.25), (1.4, 1.5), (1.6, 1.7), (1.8, 1.9), (2, 2)

: c Advertisement Effect on Port in Post Competitor = GRAPH (Perceived Advertising Spending Competitor / Normal Advertisement Spending) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.75), (1, 1), (1.2, 1.2)

: f Port in Post Competitor = Decision PostPaid * Normal Port in Post Fr Competitor * Service Quality Effect on Port in Post Competitor * Service Features Effect on Port in Post Competitor * Price Effect on Port in Post Competitor * Advertisement Effect on Port in Post Competitor

: b Flow 4 = (Desired Internal Price Post Competitor - Internal Price Post Competitor) / Response Delay for Price

: b Flow 2 = (Desired Internal Price Pre Competitor - Internal Price Pre Competitor) / Response Delay for Price

: f Maturation Post Competitor = CONVEYOR OUTFLOW

: c Price Effect on Port Out toOther Post Competitor = GRAPH (Internal Price Post Competitor / Normal Price Post) (0, 0.001), (0.2, 0.2), (0.4, 0.4), (0.6, 0.6), (0.8, 0.8), (1, 1), (1.2, 5), (1.4, 15), (1.6, 30), (1.8, 48), (2, 50), (2.2, 1000)

: c Service Features Effect on Port Out toOther Post Competitor = GRAPH (Normal Service Features Spending Per Capita / Perceived Service Features Spending per Capita Competitor) (0, 0.001), (1, 1), (2, 50), (3, 200), (4, 800), (5, 1800), (6, 1990), (7, 2000)

: c Service Quality Effect on Port Out toOther Post Competitor = GRAPH (Normal Service Quality Spending / Perceived Service Quality Spending Competitor) (0, 0.001), (1, 1), (2, 50), (3, 200), (4, 800), (5, 1800), (6, 1990), (7, 2000)

: f Port Out to Other Post Competitor = PostPaid Competitor * Normal Port Out toOther Post Fr Competitor * Price Effect on Port Out toOther Post Competitor * Service Features Effect on Port Out toOther Post Competitor * Service Quality Effect on Port Out toOther Post Competitor

: f Maturation Pre = CONVEYOR OUTFLOW

: c Price Effect on Port Out toOther Pre = GRAPH (Internal Price Pre / Normal Price Pre) (0, 0.001), (0.2, 0.2), (0.4, 0.4), (0.6, 0.6), (0.8, 0.8), (1, 1), (1.2, 5), (1.4, 15), (1.6, 30), (1.8, 48), (2, 50), (2.2, 1000)

: c Service Features Effect on Port Out toOther Pre = GRAPH (Normal Service Features Spending Per Capita / Perceived Service Features Spending per Capita) (0, 0.001), (1, 1), (2, 50), (3, 200), (4, 800), (5, 1800), (6, 1990), (7, 2000)

: c Service Quality Effect on Port Out toOther Pre = GRAPH (Normal Service Quality Spending / Perceived Service Quality Spending) (0, 0.001), (1, 1), (2, 50), (3, 200), (4, 800), (5, 1800), (6, 1990), (7, 2000)

: f Port Out to Other Pre = PrePaid * Normal Port Out toOther Pre Fr * Price Effect on Port Out toOther Pre * Service Features Effect on Port Out toOther Pre * Service Quality Effect on Port Out toOther Pre

: f Maturation Pre Competitor = CONVEYOR OUTFLOW

: c Price Effect on Port Out toOther Pre Competitor = GRAPH (Internal Price Pre Competitor / Normal Price Pre) (0, 0.001), (0.2, 0.2), (0.4, 0.4), (0.6, 0.6), (0.8, 0.8), (1, 1), (1.2, 5), (1.4, 15), (1.6, 30), (1.8, 48), (2, 50), (2.2, 1000)

: c Service Features Effect on Port Out toOther Pre Competitor = GRAPH (Normal Service Features Spending Per Capita / Perceived Service Features Spending per Capita Competitor) (0, 0.001), (1, 1), (2, 50), (3, 200), (4, 800), (5, 1800), (6, 1990), (7, 2000)

: c Service Quality Effect on Port Out toOther Pre Competitor = GRAPH (Normal Service Quality Spending / Perceived Service Quality Spending Competitor) (0, 0.001), (1, 1), (2, 50), (3, 200), (4, 800), (5, 1800), (6, 1990), (7, 2000)

: f Port Out to Other Pre Competitor = PrePaid Competitor * Normal Port Out toOther Pre Fr * Price Effect on Port Out toOther Pre Competitor * Service Features Effect on Port Out toOther Pre Competitor * Service Quality Effect on Port Out toOther Pre Competitor

: f Other Pre2Post = Other PrePaid * Normal Pre2Post Market Fr

: c Price Effect on Port in From Other Post = GRAPH (Acquisition Price Post / Normal Price Post) (0, 2), (0.2, 1.9), (0.4, 1.7), (0.6, 1.5), (0.8, 1.25), (1, 1), (1.2, 0.75), (1.4, 0.5), (1.6, 0.3), (1.8, 0.1), (2, 0.001)

: c Advertisement Effect on Port in From Other Post = GRAPH (Perceived Advertising Spending / Normal Advertisement Spending) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.75), (1, 1), (1.2, 1.2)

: f Port in From Other Post = Other PostPaid * Normal Port in From Other Post Fr * Price Effect on Port in From Other Post * Advertisement Effect on Port in From Other Post

: c Price Effect on Port in From Other Post Competitor = GRAPH (Acquisition Price Post Competitor / Normal Price Post) (0, 2), (0.2, 1.9), (0.4, 1.7), (0.6, 1.5), (0.8, 1.25), (1, 1), (1.2, 0.75), (1.4, 0.5), (1.6, 0.3), (1.8, 0.1), (2, 0.001)

: c Advertisement Effect on Port in From Other Post Competitor = GRAPH (Perceived Advertising Spending Competitor / Normal Advertisement Spending) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.75), (1, 1), (1.2, 1.2)

: f Port in From Other Post Competitor = Other PostPaid * Normal Port in From Other Post Fr * Price Effect on Port in From Other Post Competitor * Advertisement Effect on Port in From Other Post Competitor

: c Price Effect on Port in From Other Pre = GRAPH (Acquisition Price Pre / Normal Price Pre) (0, 3), (0.2, 2.9), (0.4, 2.75), (0.6, 2.3), (0.8, 1.75), (1, 1), (1.2, 0.5), (1.4, 0.3), (1.6, 0.2), (1.8, 0.1), (2, 0.001)

: c Advertisement Effect on Port in From Other Pre = GRAPH (Perceived Advertising Spending / Normal Advertisement Spending) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.75), (1, 1), (1.2, 1.2)

: f Port in From Other Pre = Other PrePaid * Normal Port in From Other Pre Fr * Price Effect on Port in From Other Pre * Advertisement Effect on Port in From Other Pre

: c Price Effect on Port in From Other Pre Competitor = GRAPH (Acquisition Price Pre Competitor / Normal Price Pre) (0, 3), (0.2, 2.9), (0.4, 2.75), (0.6, 2.3), (0.8, 1.75), (1, 1), (1.2, 0.5), (1.4, 0.3), (1.6, 0.2), (1.8, 0.1), (2, 0.001)

: c Advertisement Effect on Port in From Other Pre Competitor = GRAPH (Perceived Advertising Spending Competitor / Normal Advertisement Spending) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.75), (1, 1), (1.2, 1.2)

: f Port in From Other Pre Competitor = Other PrePaid * Normal Port in From Other Pre Fr * Price Effect on Port in From Other Pre Competitor * Advertisement Effect on Port in From Other Pre Competitor

: b Adjustment Flow1 = (Effective Advertising Spending - Perceived Advertising Spending) / Advertising Perception Delay

: b Adjustment Flow2 = (Advertising Spending Competitor - Perceived Advertising Spending Competitor) / Advertising Perception Delay Competitor

: b Adjustment Flow3 = (Adjustment Stock 5 - Perceived Service Features Spending per Capita) / Service Features Perception Delay

: b Adjustment Flow4 = (Adjustment Stock 8 - Perceived Service Features Spending per Capita Competitor) / Service Features Perception Delay Competitor

: b Adjustment Flow9 = (Adjustment Stock2 - Perceived Service Quality Spending) / Service Quality Perception Delay

: b Adjustment Flow22 = (Adjustment Stock8 - Perceived Service Quality Spending Competitor) / Service Quality Perception Delay Competitor

: c Service Features Effect on Port in Post = GRAPH (Perceived Service Features Spending per Capita Competitor / Normal Service Features Spending Per Capita) (0, 3), (0.333, 1.8), (0.667, 1.3), (1, 1), (1.333, 0.85), (1.667, 0.667), (2, 0.5), (2.333, 0.333), (2.667, 0.15), (3, 0.001)

: c Service Quality Effect on Port in Post = GRAPH (Perceived Service Quality Spending Competitor / Normal Service Quality Spending) (0, 2), (0.2, 1.9), (0.4, 1.7), (0.6, 1.5), (0.8, 1.25), (1, 1), (1.2, 0.75), (1.4, 0.5), (1.6, 0.3), (1.8, 0.1), (2, 0.001)

: c Price Effect on Port in Post = GRAPH (Internal Price Post Competitor / Acquisition Price Post) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.7), (1, 1), (1.2, 1.25), (1.4, 1.5), (1.6, 1.7), (1.8, 1.9), (2, 2)

: c Advertisement Effect on Port in Post = GRAPH (Perceived Advertising Spending / Normal Advertisement Spending) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.75), (1, 1), (1.2, 1.2)

: f Port in Post = PostPaid Competitor * Normal Port in Post Fr * Service Features Effect on Port in Post * Service Quality Effect on Port in Post * Price Effect on Port in Post * Advertisement Effect on Port in Post

: c Price Effect on Pre2Post = GRAPH ( (Acquisition Price Post / Normal Price Post) / (Internal Price Pre / Normal Price Pre)) (0, 2), (0.2, 1.9), (0.4, 1.7), (0.6, 1.5), (0.8, 1.25), (1, 1), (1.2, 0.75), (1.4, 0.5), (1.6, 0.3), (1.8, 0.1), (2, 0.001)

: f Pre2Post = PrePaid * Normal Pre2Post Fr * Price Effect on Pre2Post

: c Service Features Effect on Port in Pre Competitor = GRAPH (Perceived Service Features Spending per Capita / Normal Service Features Spending Per Capita) (0, 4), (0.2, 3), (0.4, 2.3), (0.6, 1.5), (0.8, 1.25), (1, 1), (1.2, 0.75), (1.4, 0.5), (1.6, 0.3), (1.8, 0.1), (2, 0.001)

: c Service Quality Effect on Port in Pre Competitor = GRAPH (Perceived Service Quality Spending / Normal Service Quality Spending) (0, 1.5), (0.333, 1.3), (0.667, 1.15), (1, 1), (1.333, 0.85), (1.667, 0.667), (2, 0.5), (2.333, 0.333), (2.667, 0.15), (3, 0.001)

: c Price Effect on Port in Pre Competitor = GRAPH (Internal Price Pre / Acquisition Price Pre Competitor) (0, 0.001), (0.2, 0.1), (0.4, 0.2), (0.6, 0.3), (0.8, 0.5), (1, 1), (1.2, 1.75), (1.4, 2.3), (1.6, 2.75), (1.8, 2.9), (2, 3)

: c Advertisement Effect on Port in Pre Competitor = GRAPH (Perceived Advertising Spending Competitor / Normal Advertisement Spending) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.75), (1, 1), (1.2, 1.2)

: f Port in Pre Competitor = PrePaid * Normal Port in Pre Fr * Service Features Effect on Port in Pre Competitor * Service Quality Effect on Port in Pre Competitor * Price Effect on Port in Pre Competitor * Advertisement Effect on Port in Pre Competitor

: c Price Effect on Pre2Post Competitor = GRAPH ( (Acquisition Price Post Competitor / Normal Price Post) / (Internal Price Pre Competitor / Normal Price Pre)) (0, 2), (0.2, 1.9), (0.4, 1.7), (0.6, 1.5), (0.8, 1.25), (1, 1), (1.2, 0.75), (1.4, 0.5), (1.6, 0.3), (1.8, 0.1), (2, 0.001)

: f Pre2Post Competitor = PrePaid Competitor * Normal Pre2Post Fr * Price Effect on Pre2Post Competitor

: c Service Features Effect on Port in Pre = GRAPH (Perceived Service Features

Spending per Capita Competitor / Normal Service Features Spending Per Capita) (0, 4), (0.2, 3), (0.4, 2.3), (0.6, 1.5), (0.8, 1.25), (1, 1), (1.2, 0.75), (1.4, 0.5), (1.6, 0.3), (1.8, 0.1), (2, 0.001)

: c Service Quality Effect on Port in Pre = GRAPH (Perceived Service Quality Spending Competitor / Normal Service Quality Spending) (0, 1.5), (0.333, 1.3), (0.667, 1.15), (1, 1), (1.333, 0.85), (1.667, 0.667), (2, 0.5), (2.333, 0.333), (2.667, 0.15), (3, 0.001)

: c Price Effect on Port in Pre = GRAPH (Internal Price Pre Competitor / Acquisition Price Pre) (0, 0.001), (0.2, 0.1), (0.4, 0.2), (0.6, 0.3), (0.8, 0.5), (1, 1), (1.2, 1.75), (1.4, 2.3), (1.6, 2.75), (1.8, 2.9), (2, 3)

: c Advertisement Effect on Port in Pre = GRAPH (Perceived Advertising Spending / Normal Advertisement Spending) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.75), (1, 1), (1.2, 1.2)

: f Port in Pre = PrePaid Competitor * Normal Port in Pre Fr * Service Features Effect on Port in Pre * Service Quality Effect on Port in Pre * Price Effect on Port in Pre * Advertisement Effect on Port in Pre

: c Effective Service Features Spending per Capita Competitor = IF Projected Desired Cost Competitor ¿ Projected Revenue Competitor * (1 + Overspending Coefficent) THEN Desired Service Features Spending per Capita Competitor * ( (Projected Revenue Competitor * (1 + Overspending Coefficent)) / Projected Desired Cost Competitor) ELSE Desired Service Features Spending per Capita Competitor

: b Flow 6 = (Effective Service Features Spending per Capita Competitor - Service Features Spending per Capita Competitor) / Response Delay for Investment

: c Effective Service Quality Spending Competitor = IF Projected Desired Cost Competitor ¿ Projected Revenue Competitor * (1 + Overspending Coefficent) THEN Desired Service Quality Spending Competitor * ( (Projected Revenue Competitor * (1 + Overspending Coefficent)) / Projected Desired Cost Competitor) ELSE Desired Service Quality Spending Competitor

: b Flow 7 = (Effective Service Quality Spending Competitor - Service Quality Spending Competitor) / Response Delay for Investment

: c Advertisement Effect on Acquisition Post = GRAPH (Perceived Advertising Spending / Normal Advertisement Spending) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.75), (1, 1), (1.2, 1.2)

: c Price Effect on Acquisition Post = GRAPH (Acquisition Price Post / Normal Price Post) (0, 2), (0.2, 1.9), (0.4, 1.7), (0.6, 1.5), (0.8, 1.25), (1, 1), (1.2, 0.75), (1.4, 0.5), (1.6, 0.3), (1.8, 0.1), (2, 0.001)

: f Acquisition Post = Normal Acquisition Rate Post * Advertisement Effect on Acquisition Post * Price Effect on Acquisition Post

: c Price Effect on Acquisition Pre = GRAPH (Acquisition Price Pre / Normal Price Pre) (0, 3), (0.2, 2.9), (0.4, 2.75), (0.6, 2.3), (0.8, 1.75), (1, 1), (1.2, 0.5), (1.4, 0.3), (1.6, 0.2), (1.8, 0.1), (2, 0.001)

: c Advertisement Effect on Acquisition Pre = GRAPH (Perceived Advertising Spending / Normal Advertisement Spending) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.75), (1, 1), (1.2, 1.2)

: f Acquisition Pre = Normal Acquisition Rate Pre * Price Effect on Acquisition Pre * Advertisement Effect on Acquisition Pre

: f Fixed Revenue Inflow = (Acquisition Pre + Port in From Other Pre + Port in Pre) * Acquisition Price Pre + Post Contract Rate * Contract Price + (Acquisition Post + Pre2Post + Port in Post + Port in From Other Post) * Acquisition Price Post

: c Price Effect on Acqsition Pre Competitor = GRAPH (Acquisition Price Pre Competitor / Normal Price Pre) (0, 3), (0.2, 2.9), (0.4, 2.75), (0.6, 2.3), (0.8, 1.75), (1, 1), (1.2, 0.5), (1.4, 0.3), (1.6, 0.2), (1.8, 0.1), (2, 0.001)

: c Advertisement Effect on Acqusition Pre Competitor = GRAPH (Perceived Advertising Spending Competitor / Normal Advertisement Spending) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.75), (1, 1), (1.2, 1.2)

: f Acqusition Pre Competitor = Normal Acqusition Rate Pre Competitor * Price Effect on Acqsition Pre Competitor * Advertisement Effect on Acqusition Pre Competitor

: c Price Effect on Acqusition Post Competitor = GRAPH (Acquisition Price Post Competitor / Normal Price Post) (0, 2), (0.2, 1.9), (0.4, 1.7), (0.6, 1.5), (0.8, 1.25), (1, 1), (1.2, 0.75), (1.4, 0.5), (1.6, 0.3), (1.8, 0.1), (2, 0.001)

: c Advertisement Effect on Acqusition Post Competitor = GRAPH (Perceived Advertising Spending Competitor / Normal Advertisement Spending) (0, 0.001), (0.2, 0.1), (0.4, 0.3), (0.6, 0.5), (0.8, 0.75), (1, 1), (1.2, 1.2)

: f Acqusition Post Competitor = Normal Acqusition Rate Post Competitor * Price Effect on Acqusition Post Competitor * Advertisement Effect on Acqusition Post Competitor

: f Fixed Revenue Inflow Competitor = (Acqusition Pre Competitor + Port in From Other Pre Competitor + Port in Pre Competitor) * Acquisition Price Pre Competitor + (Acqusition Post Competitor + Pre2Post Competitor + Port in Post Competitor + Port in From Other Post Competitor) * Acquisition Price Post Competitor

: f Fixed Revenue Outflow = CONVEYOR OUTFLOW

: f Fixed Revenue Outflow Competitor = CONVEYOR OUTFLOW

: c Market Cap = (Total Customer PostPaid * 100) / All Customers

: c Timer = TIME

TIME SPECS:

STARTTIME = 0

STOPTIME = 120

DT = 0.25

INTEGRATION = EULER

RUNMODE = NORMAL

PAUSEINTERVAL = 3