

MULTI-AGENT SIMULATION OF DISPUTED MARKETING SITUATIONS

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KEYWORDS

Simulation, Intelligent agent, multi-agent system, agent-basic technology, marketing, price strategy.

ABSTRACT

This article examines multi-agent simulation model of interaction and choice of optimum pricing strategy of firms - oligopolists during competitive struggle for profit and market share. Methods, algorithms and program realization in universal simulation system Simplex3 (Schmidt 1996, 2001) *agent-based simulation* of interaction of competing elements in disputed marketing situations are described. *The feature* of agent-oriented *models* is that they describe individual characteristics of all participants of the market (Gorni 1996, Weppner 1998) and their criterion functions on each step of interaction, instead of the average or generalized parameters of a condition.

The considered simulation model of the market with suppliers and buyers of production opens the **events** mechanism of the conflict and dynamics of interaction of competing elements - *intellectual agents* during his sanction and stabilization of a condition status of the marketing environment.

INTRODUCTION

Marketing is dynamically developing industrial-organizational system functioning in conditions of information uncertainty, determined first of all, by rigid competition between firms-manufacturers and firms-resellers. However dynamics of the real market is in most cases unpredictable and its final condition status cannot be predicted analytically or by the logic analysis from an initial condition status as it grows out from multistage interaction of many active elements of the market environment and outage factors. A characteristic example is *the disputed market situation with contestant firms* - the manufacturers of the goods, struggling for maximum profit and a market share. In this case simulation of behaviour of each active element in conditions of *counteraction* is concerned with a choice of strategy of pricing with allowance for condition statuses and strategies of others oligopolists - competitors, their weak and strengths, the information on a financial position and features of marketing and productive activity.

Price strategy is determined by the purposes of the company - mastering and deductions of a determined

market share, maintenance of the planned volume of the profit, suppression of activity of competitors, etc. depending on character of demand, manufacturing costs and sale of goods, real value of the goods, strategy of competitors, etc.

The initial price is established, proceeding from product cost and the planned profit, solvency of the buyer and the price developed in the market; the price of indifference at which for the consumer its all the same, the goods of what firm to get. *The current and final prices* differ from initial depending on price strategy of firm-oligopolist and can be reduced in process of development and market saturation on a background of a competition or to raise at determined favorable situations.

The aim of *multi-agent modeling* is studying the influence of various types of price strategy on oligopol market per market share, profit and a sales volume depending on an established commodity price, market average price and qualities of the goods, strategy of competitors, heterogeneities of the market, not price factors and other marketing characteristics. For this purpose models and algorithms of *agent-based simulation* of interaction of competing elements - *the intellectual agents (IA)* varying the properties and behaviour depending on a condition status of other elements and the marketing environment are offered. Models of IA, describing individual characteristics of a condition status and behaviour of each participant of the market conflict on each step of interaction are consolidated in *multi-agent simulation model* of the marketing situation reproducing dynamic interaction of intellectual agents - contestant firms with an opportunity of identification of a condition status and forecasting of optimum price strategy.

Strategies of the resolution of conflict in all cases are reduced to two consecutive phases: *individual struggle* with counteractive party and in case of exhaustion of its opportunities - to search of the *cooperative joint solutions* conducting to compromise achievement of an overall aim. Thus the strategy realization in current environment may be achieved by a logic sequence of operations that are depends on individual agent parameters changing and estimation.

SIMULATION MODELING OF OLIGOPOL DISPUTE

The block diagram of agent-oriented imitating model of oligopol market is submitted on fig. 1 and includes functional blocks of the firms-sellers struggling for

maximum profit and a market share, block *Market* and collective block *N* of buyers of *Buyer* production. Marketing process of stabilization of the market for two oligopolists with the subsequent occurrence of the third is considered. For each buyer his requirements to a product and firm are generated. For this purpose in basis component *Buyer* elements of a bidimensional array which rows correspond to criteria, and columns - to serial numbers of buyers are played. For every oligopolist in a random way, parameters of an offered product and accompanying services are played as well. Each firm is described in a separate basis component, accordingly *Firm1*, *Firm2*, *Firm3* with parameters of a condition status (the price, volume of tenders, discounts, advertising, quality, commodity range, the credit of trust, remoteness, delivery) in arrays *par [1..9]* and in mobile component *Query*.

In the transactive period the buyer, coming on the market (basis component *Market*), considers the tender

of each firm and chooses as much as possible corresponding to his requirements. Thus calculation of buyers and quantities of the purchased goods for each of firms is conducted. In the end of the transactive period totals are summed up, and the information on quantity of buyers and on remnants of the goods on warehouses is sent to each firm. Proceeding from this and taking into account the last experience (the sales volume and demand for the last periods), oligopolist chooses one of possible strategies for the following period of time with a variation of the price, tenders and not price factors. Variables of a condition status of basis components of structure of imitating model are (fig. 1):

Cust F1-Cust F3 - number of clients, accordingly firms 1-3;

QueryStock1-QueryStock3, *FirmStock* - stores of tenders on each firm and as a whole;

balances [1..3] - array of remnants of the goods;

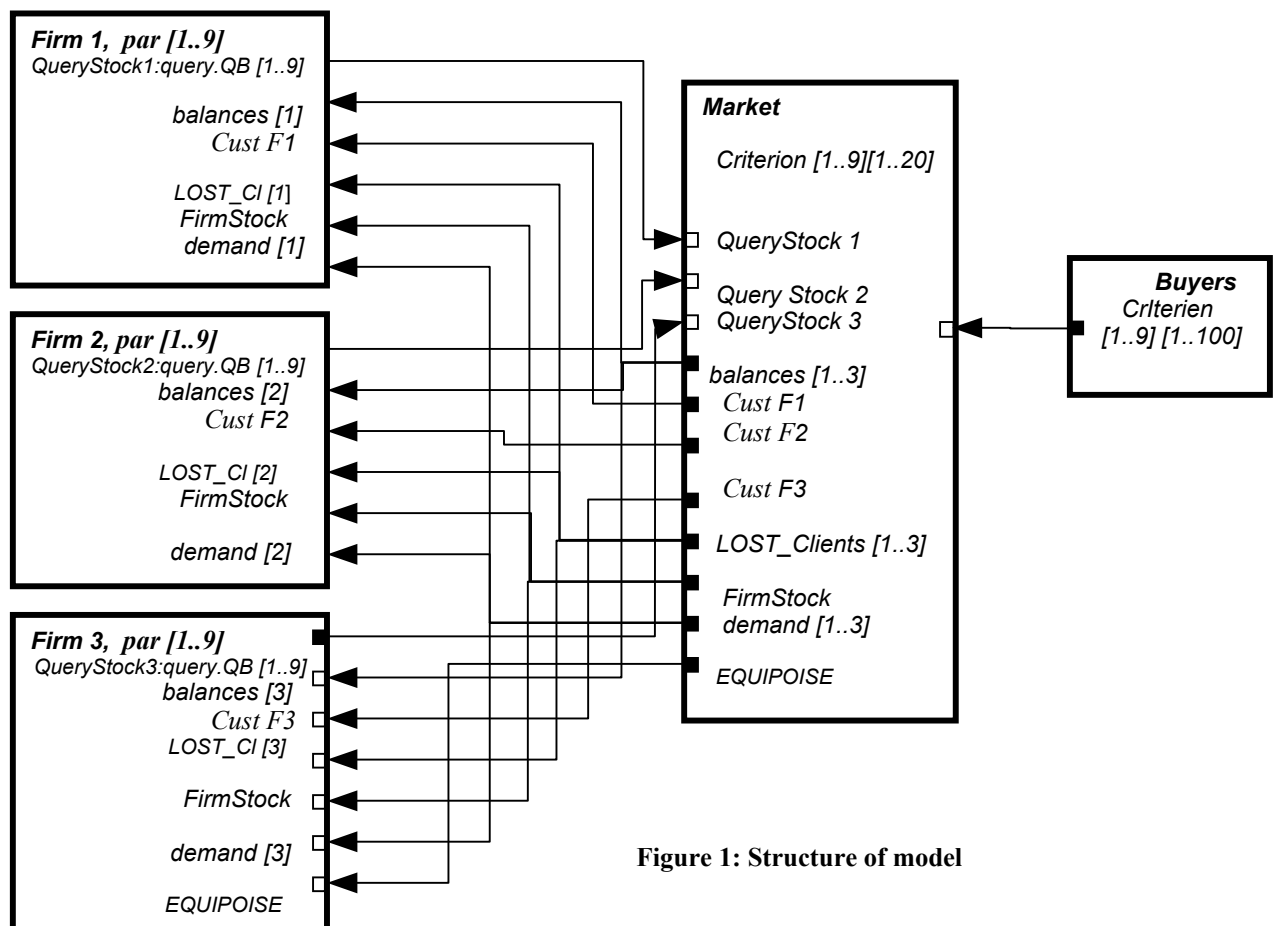


Figure 1: Structure of model

LOST_Clients [1..3] - array, which elements shows whether there are at the competitor not catered clients; *EQUIPOISE* - the logic variable equal TRUE at an establishment in the market of balance of the prices; *Criterien [1..9] [1..100]* - array of criteria of buyers; *demand [1..3]* - array, maintaining volume of missed sales on each firm.

COMMON ALGORITHM OF MODELING STRATEGY

The algorithm of a choice of strategy is realized in language *Simplex-MDL* in universal system of imitating modeling *Simplex3* (Schmidt, 1996, 2001), developed in Passau university (Germany) and is reduced to reproduction of the following events

(Fig. 2).

Event 1. Each seller traces behaviour of competitors, determining for itself an average price of the goods *average_price* in a preceding period. Depending on, whether there will be a current price *par [1]* more or

less than average, its reduction or increase at 1 % follows.

In **event 2** each firm at presence of not catered clients increases the scope of supply *par [2]* by the missing size *dem [i]*.

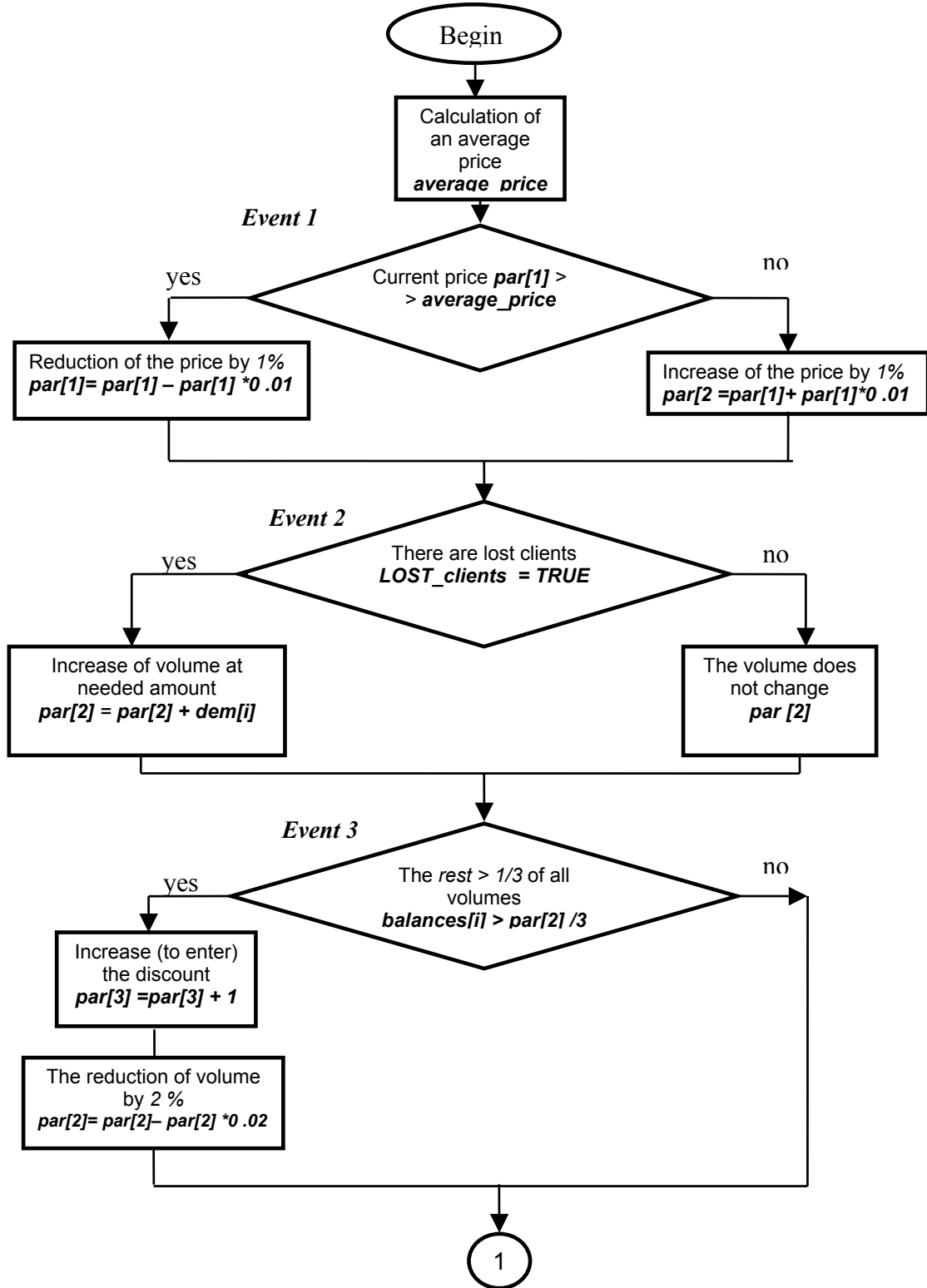


Figure 2: Algorithm of a choice of strategy in dependence on current prices of competitors and own demand (the beginning)

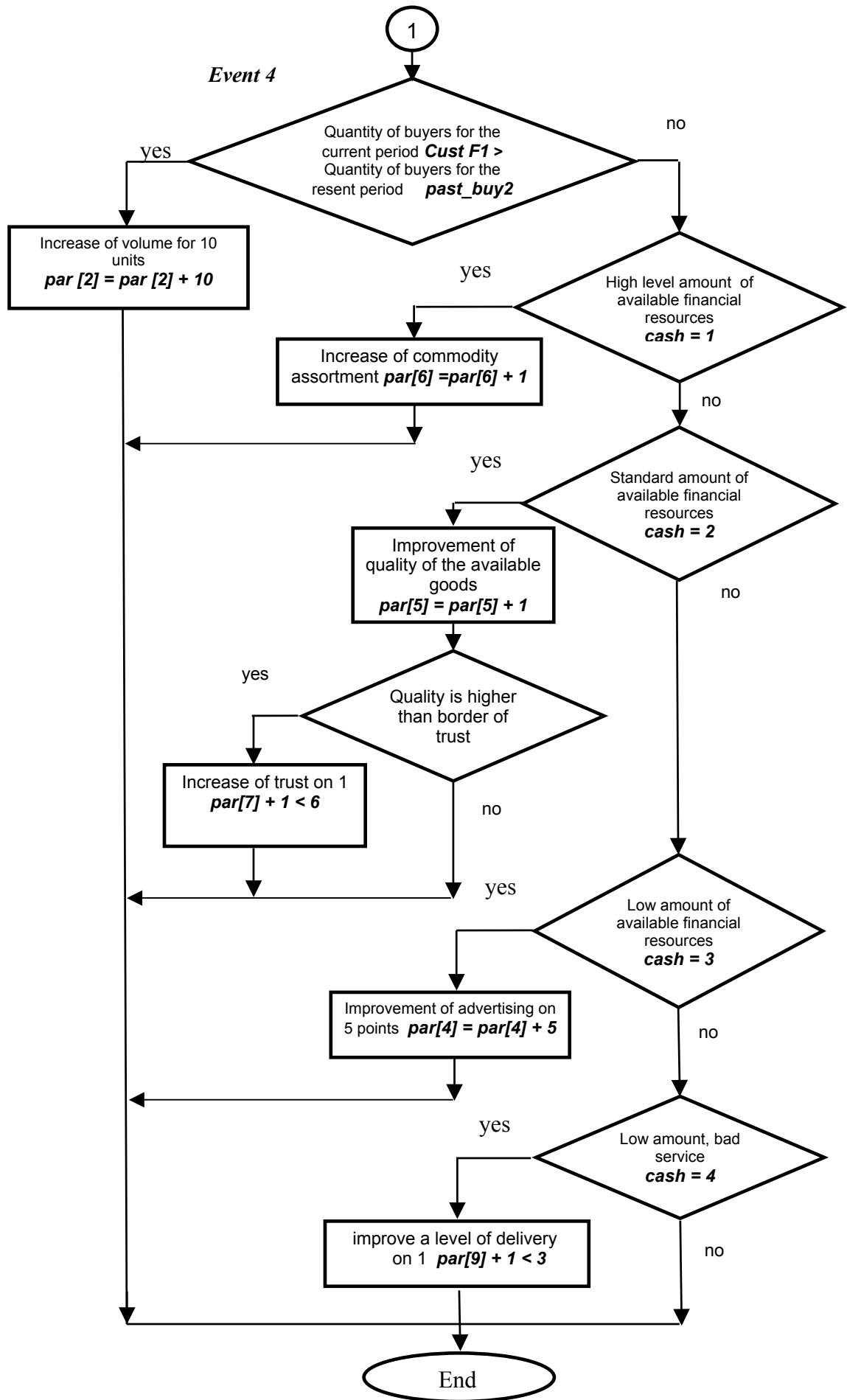


Figure 2: Algorithm of a choice of strategy in dependence on current prices of competitors and own demand (the end)

Event 3. If the stock balance of firm *balances [i]* is more than 1/3 of all let out volumes *par [2]*, oligopolist enters discounts for sale and reduces the let out volume by determined percent (for example, on 2 %).

Further, proceeding from fluctuations of demand, oligopolist varies not price factors (**event 4**). If in the current period the quantity of buyers *Cust F* increases in comparison with the last period *past_buy2* the firm increases volume of tenders by 10 units. If demand is reduced, the firm undertakes actions according to quantity of available free money resources (variable *cash*). In the accepted strategy at the sufficient sum of receipts, *cash = 1*, oligopolist expands the commodity range, putting into circulation the new goods. The further fluctuations of a variable *cash*, correspond to reducing of money resources and amplification of influence of not price factors. So at *cash = 2* oligopolist aspires to raise quality of the available goods, improving thus its image and increasing trust of clients. At *cash=3* advertising improves, and at *cash = 4* - conditions of delivery, etc

MULTI-AGENT SIMULATION MODEL OF MARKETING SYSTEM

Multi-agent simulation model is made of the *basis MDL-components* describing a condition status and dynamics of behaviour of elements of system, *the organizational components* specifying structure of interrelations between basis components, and *mobile components* - for the description of the reports placed in *accumulative arrays* and forming turns on servicing. *The MDL-description* of structure of model organizational component HIGH LEVEL COMPONENT according to the scheme of connections of basis components (fig. 1) has the following appearance:

HIGH LEVEL COMPONENT *Market_HIGH*

SUBCOMPONENTS

Firm1, Firm2, Firm3, buyer, Market

COMPONENT CONNECTIONS

Firm 1.*QueryStock1*--> Market.*Qstock 1*;

Firm 2.*QueryStock2*--> Market.*Qstock 2*;

Firm 3.*QueryStock3*--> Market.*Qstock 3*;

Buyer. criterion {i OF 1..9} {j OF 1..100} -->

Market. Criterion [i][j] ;

Firm1.parameters1 {i OF 1..9}-->Firm3.parameters1 [i]

Firm2.parameters2 {i OF 1..9}-->Firm3.parameters2 [i]

Market. g --> Firm1.g , Firm2.g , Firm3. g

Quantity of buyers

Market. *Cust F1* --> Firm1.*Cust F1*;

Market. *Cust F2* --> Firm2. *Cust F2*;

Market. *Cust F3* --> Firm3. *Cust F3*;

Non-realized remnants

Market. *balances[1]* --> Firm1.*balances[1]*;

Market. *balances [2]* --> Firm2. *balances[2]*;

Market. *balances [3]* --> Firm3. *balances[3]*;

.....
Market. *EQUIPOISE* --> Firm3. *EQUIPOISE*;
END OF *Market_HIGH*

Two self-contained components are consolidated via communication line on which the behaviour of a variable from one component is taken into account in the other. Thus in section COMPONENT CONNECTIONS the name of a component and his imported sensor variable directed on a sensor input of other component is underlined.

The behaviour of the agent-buyer is described by basis component *Buyer* which should choose the seller and establish a volume of orders by criteria of seller's option and a product. The actions of agents-sellers described in basis components *Firm1*, *Firm2*, *Firm3*, are connected to a choice of price and not price strategy of each firm - oligopolist with allowance for strategy and variables of a condition status of other oligopolists-competitors transmitted on sensor communications.

Work of model during the set interval of time *TNext* consists of lines of consecutive conditional events (fig. 2). Transition from one event to another is managed with special signals-indicators. After the end of simulation, it is signaled for making up of the summary information on past transactive to the period then the new reference point of time *Tnext* for new transactive the period is established.

SIMULATION RESULTS

Results of simulation of price strategy of two oligopolists - competitors with the subsequent occurrence of the third in universal simulation system *Simplex3* are submitted on fig. 3 - 7. The chart on fig. 3 shows process of elastic pricing at the big distinction of the initial prices and stabilization of the market at occurrence in him the new competitor with the price strategy. On fig. 4 the competition is shown in fluctuation by a market share (number of buyers) of each firm and possible allocating of shares after occurrence in the market new oligopolist is shown. The Fig. 5 - 7 show dynamics of a level of demand on production of each firm as chart of fluctuation of volumes of tenders, sales and remnants for the sale, developing in modeled processes of competition and dynamic interaction of intellectual agents

CONCLUSIONS

Multi-agent simulation of marketing system opens and explains the mechanism of strategy of pricing of the competing parties in disputed situations of counteraction of active elements in the marketing environment. Decision-making is directed on studying and forecasting of stabilization of the market at various economic and social indignations, to a choice of optimum marketing strategies, balancing of supplies and demands in the current conditions. Therefore development of multi-agent simulation

models reflecting variety of behaviour and interaction of self-contained links of marketing system is socially significant and actual for an estimation of complex

situations and computer support of accepting of critical decisions.

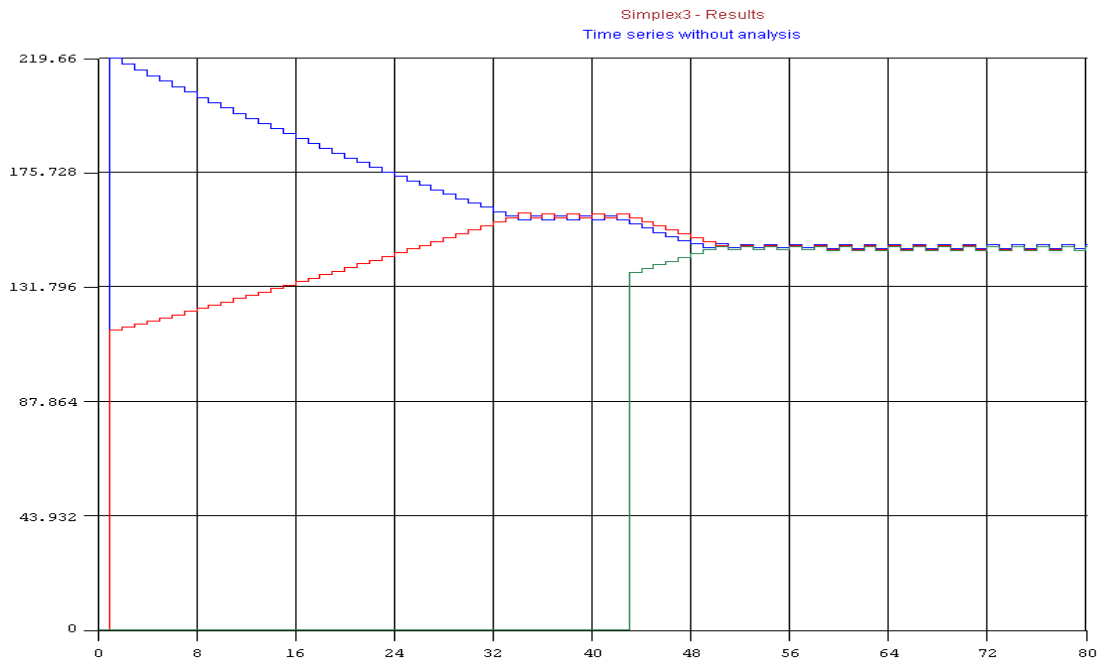


Figure 3: Process of stabilization of the market at strategy of elastic pricing

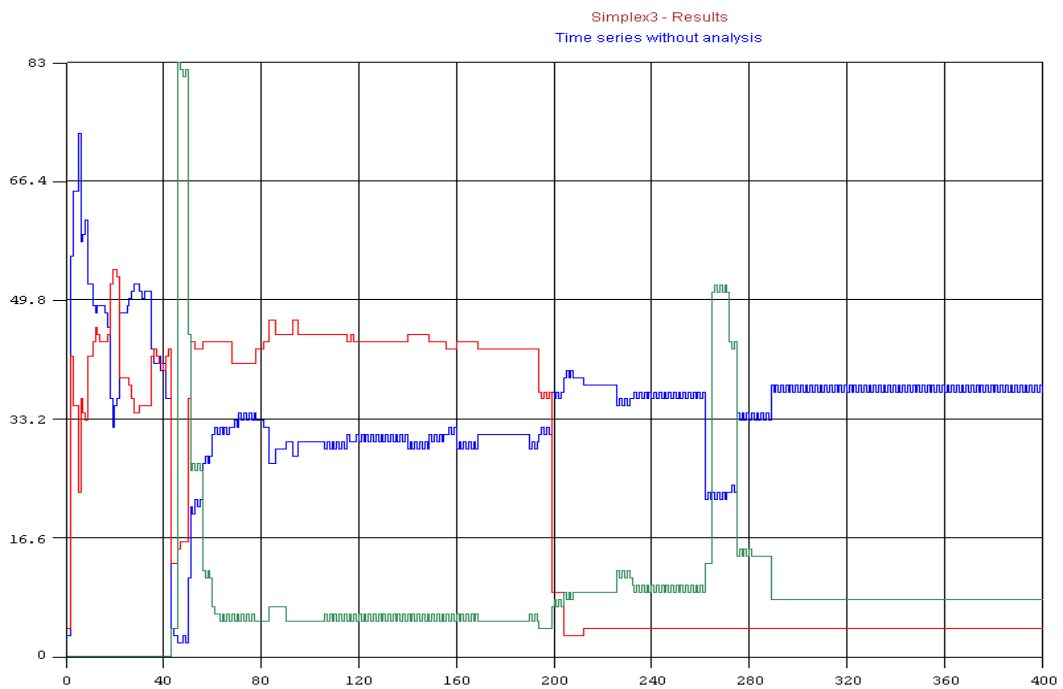


Figure 4: Quantity of buyers of each firm

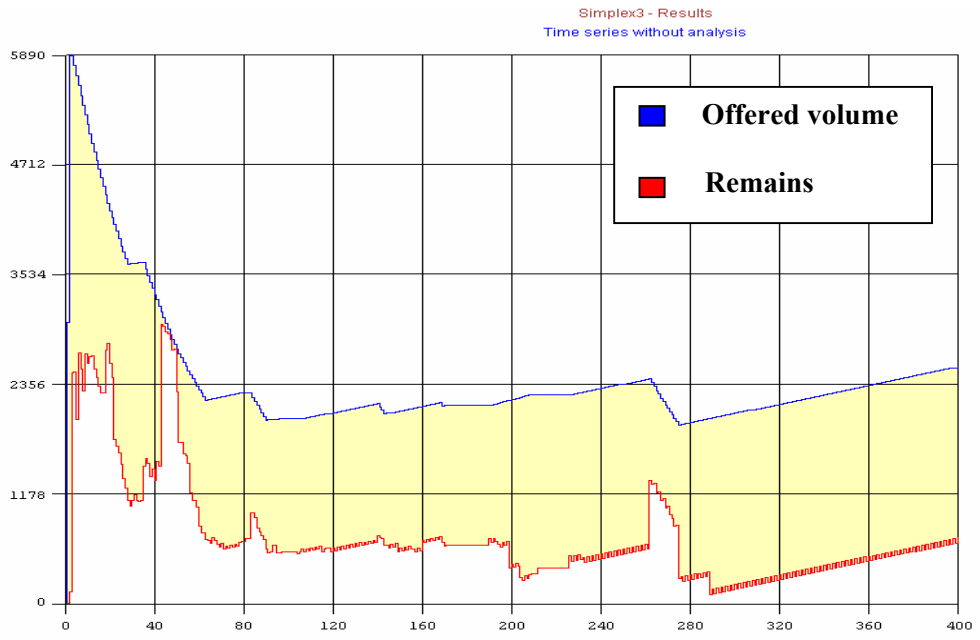


Figure 5: An offered volume and the remains of the goods of first firm

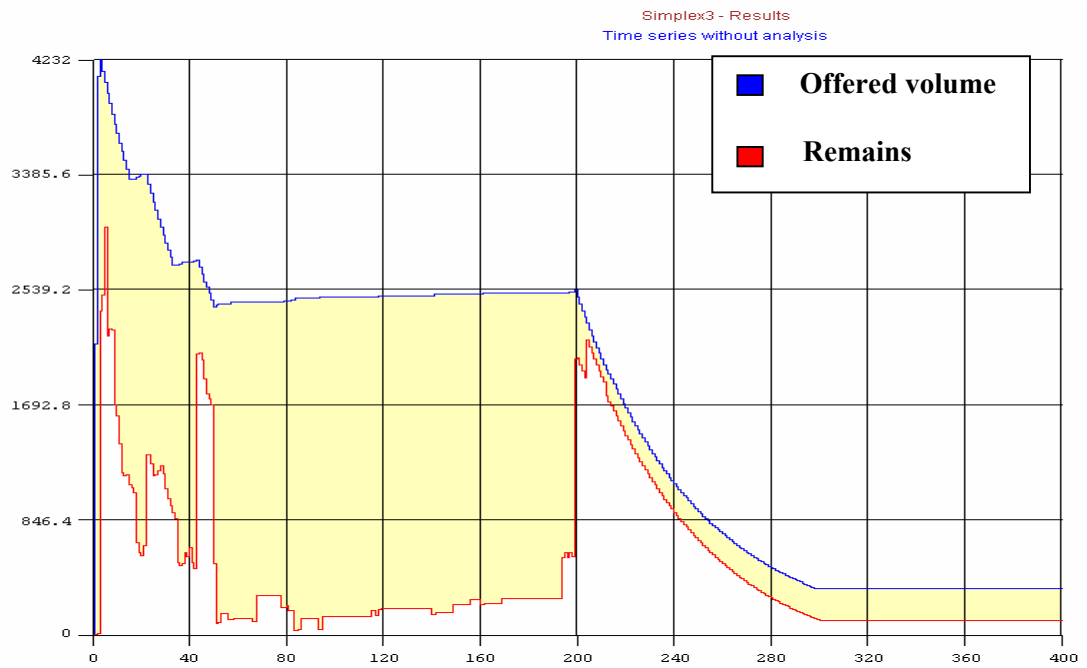


Figure 6: An offered volume and the remains of the goods of second firm

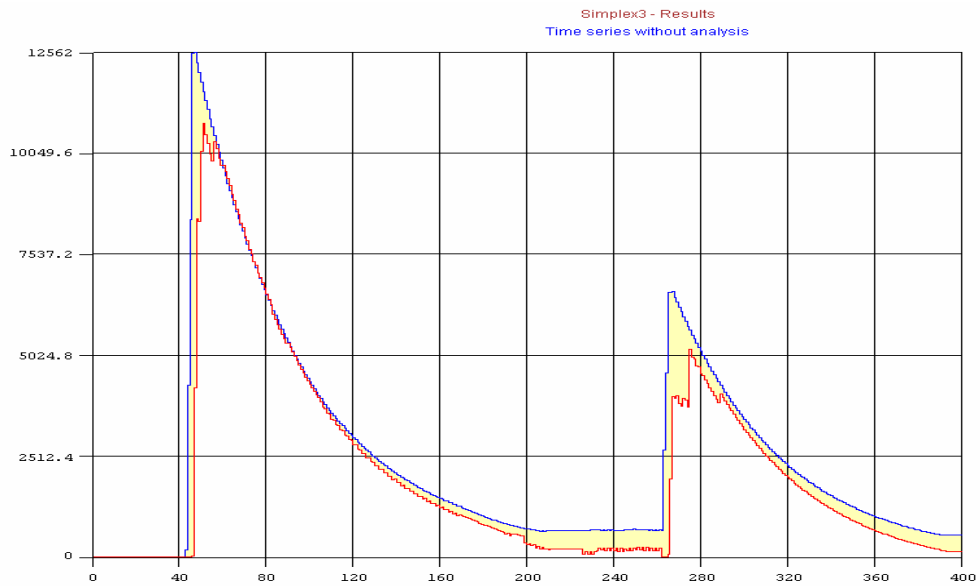


Figure 7: An offered volume and the remains of the goods of third firm

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