

Dynamic Model of Double Electronic Vickrey Auction

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Abstract. The paper deals with different approaches to the definition of e-commerce, including special mechanisms for the distribution of goods and payments, such as auction model. Different formats of auctions that change welfare of their participants are investigated. Software modules were developed for researching the effectiveness of double electronic Vickrey auction. It is defined that in double Vickrey auction incentives for most buyers and sellers are created to reveal their true types. The developed software module of double Vickrey auction showed the highest efficiency in the terms of social welfare among alternative formats and disproved the ability of Vickrey auction to achieve results like market mechanism of perfect competition.

Keywords. e-commerce, online auction, e-auction, Vickrey auction, social welfare.

Key Terms. ElectronicAuction, Software, DoubleAuction, SocialWelfare.

1. Introduction

The current phase of civilization development is characterized by drastic transformations in all spheres of life: from culture and sport to politics and economics. Taking advantage of new methods, changing subject matter of investigations, using neologisms such as digital economy, information economy, info-networks economy, knowledge-based economy, Internet economy, "new" economy, virtual economy, service economy. The variety of modern categories is typical for the modern stage of evolutionary development of international economy, placing special emphasis on the leading role of the triad of determinants of economic growth and development of today, which includes intellectual capital, creative and innovative factor as the basis for developing of knowledge-based economy.

Another feature of the modern epoch of human development is asymmetry of socio-economic development of the international economic system, which is deepening due to globalization. Most scientists think that essential determinants of escalation of global asymmetries lie in ICT-sphere: This leads to more considerable

disproportion in international economy and increases social polarization [1]. 'The Golden Billion' are enjoying their successful development due to unequal relationships with peripheries, as the number of "profitable niches" in global space is highly limited; therefore the way to the civilized "floor" can be easily made due to innovation-information achievements by means of integration the market mechanism into the networked information economy [2].

The technological component of modern economic processes contributes to the development of the networked economy as the synthesis of information and global economies [3].

Works of W. Vickrey, E. Daniel, Gr. Duncan, G. Karypis, J. Konstan, P. Cotler, B. Mahadevan, J. Riedl, A. Summer and B Sarwar are devoted to the problems of establishment and development of global and local e-commerce markets in terms of globalization processes. National scientists, namely A. Bereza, A. Berko, V. Vysotska, I. Kozak, F. Levchenko, Y. Lyenshyna, V. Pasichnyk, L. Patramanska, E. Strelchuk, T. Tardaskina do not stand apart of such scientific research. Theoretical and statistical investigations of this category are being conducted by some international organizations such as OECD, UNCTAD, UNISTRAL, WTO and ITU, development projects and strategic programs in regard to e-commerce are being elaborated by World Bank and EBRD.

The paper goal is to ground the impact of e-commerce on the participants' welfare through empirical experiment for electronic auctions, implemented by the means of the relevant transactions via designed software that is economically desirable distribution of goods and payments irrespective of strategic behavior of participants.

The paper has the following structure: the second part is devoted to literature review; the third one determines auction formats; the fourth part constructs the general model of double electronic Vickrey auction for true type and hidden type agents; the fifth part concludes.

2. Related Works

Development of information economy has caused formation of e-society with its integral parts: e-government in politics, e-business in economy, e-education, e-ecology, e-medicine and others (Table 1). E-trading is deemed to be a part of e-commerce which in its turn together with document control and business management makes e-business [4].

In its narrow sense e-commerce is close to e-trading because its main function is online purchase and sale transactions; in the wide sense the definition of e-commerce covers any transaction effected using computer networks [5, 6, 7].

So e-commerce is a complex of business operations carried out using computer networks (Internet, Intranet, Extranet), which are connected with the change of material rights and all processes that support this process including Electronic Data Interchange (EDI), Electronic Funds Transfer (EDF), e-trade, e-cash, e-marketing, e-banking, e-Insurance, e-logistics.

Table 1. Different ways of interpretation the category “e-commerce”

Meaning	Original	Definition
«narrow» (e-commerce=e-trade)	OECD (Organization for Economic Cooperation and Development)	An e-commerce transaction is the sale or purchase of goods or services over computer mediated networks (broad definition) or via the Internet (narrow definition) ¹ .
	R. Doernberg, L. Hinnekens, W. Hellerstein, J. Li	E-commerce means the ability to perform transactions involving the exchange of goods or services between two or more parties using electronic tools and techniques.
«wide» (e-commerce = totality of business processes)	A. Sammer, Gr. Duncan	E-commerce means any form of business process in which the interaction between the actors happens by using the Internet – technology
	UN Experts	E-commerce includes searching for information, contracting, supply of products, goods or services, making payments, sale or purchase of goods or services, whether between businesses, households, individuals, Governments and other public or private organizations, conducted over the Internet. The goods and services are ordered over the Internet, but the payment and the ultimate delivery of the good or service may be conducted on- or offline.
	WTO Specialists	E-commerce is a wide array of commercial activities carried out through the use of computers, including on-line trading of goods and services, electronic funds transfers, on-line trading of financial instruments, electronic data exchanges between companies and electronic data exchanges within a company ² .

Aspects of e-commerce are considered in Table 2 based on [8].

Table 2. Aspects of e-commerce

№	Aspect	Essence
1.	Connections	It is a method of delivery via telephone lines, computer networks, electronic means
2.	Process	It is a technology to automate business operations.
3.	Services	It is a tool to reduce costs, improve quality of goods and services and accelerate delivery.
4.	Time	E-commerce allows to carry out operation online (24 hr. per day).
5.	Space	Open Internet infrastructure makes it a global environment.

According to most experts B2B is the largest segment of e-commerce (Table 3). For example, according to UNCTAD data, B2B is a dominant segment in the American market with twice higher volume of sales compared to those of B2C (559 billion dollars against 252 billion dollars).

¹ Ecommerce Sales Topped \$1 Trillion for First Time in 2012. Available www.emarketer.com

² E-commerce and Development Key Trends and Issues Available www.wto.org/english/tratop_e/devel_e/wkshop_apr13_e/fredriksson_ecommerce_e.pdf

Table 3. Forms of interaction in e-commerce

Abbreviation	Denomination	Definition
B2B	Business-to-Business	businesses make online transactions with other businesses
B2C	Business-to-Customer	online transactions are made between businesses and individual consumers (social commerce)
B2A	Business-to-Administration	administrative document control
B2G	Business-to-Government	operations between companies and public institutions
e-government	electronic government	e-commerce model in which a government entity buys or provides goods, services, or information to businesses or individual citizens.

It is also confirmed by the structure of the e-commerce market in South Korea based on open sources³. (Fig. 1).

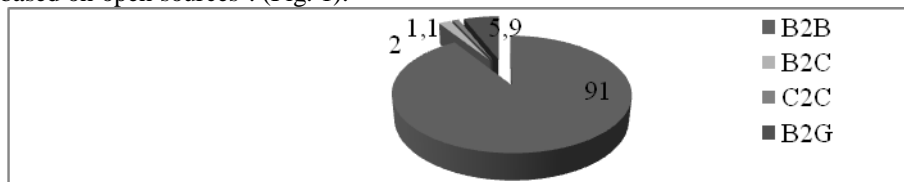


Fig. 1. The structure of e-commerce in South Korea in 2013, %

Internet-shops make an essential part of e-commerce in Ukraine - sector B2C, but B2B segment has great opportunities. For example, International center for electronic trading B2B-center has been successfully functioning for three years in Ukraine, and according to newsb2b.blogspot.com has made it possible to reduce procurement prices for Ukrainian enterprises by 20% on the average as well as procurement labor costs by 70%. The system allows to hold 43 kinds of tender, including more than 172 thousand companies from 110 countries of the world, among them 3500 companies from Ukraine: Group of companies Privat, Ukreximbank, PUMB, AZOT, Antonov, Ergopak, Rubizhne cardboard mill, Volnogorsk glass, Kolos, Ukrrosmetal, Ukrolia, and international group of companies – JTI, SoftServe, MTC, Allianz. The number of tenders held by Ukrainian segment of the B2B-center system annually increases by 60%. As of today there are two B2B trading sites functioning in Ukraine - b2b-center.ua and b2b-center.uspp.ua, the latter was created by mutual efforts of B2B-center and the Ukrainian Union of Industrialists and Entrepreneurs (UUIE), which allowed it to make online purchases.

The main determinants of insufficient development of e-business and e-commerce are undeveloped technical and technological base. Asymmetric levels of ICT-infrastructure development cause disproportional global development of e-commerce with its traditional key centers in Old and New World – Western Europe and North America, and Asia-Pacific Region (Table 4).

At the same time the growth rates of B2C sales in the developing countries are essentially falling. The highest level is traditionally demonstrated by China (63.8%)⁴. (Fig. 2).

³ The Statistics Portal. Available www.statista.com

Table 4. Comparative analysis of the development of B2C e-commerce segment all over the world in 2013 ⁴

Regions	Sales, bln. dol.	Growth rates, %	Level of coverage, %	Share of sales, %		Deviation %	
North America	419,53	12,5	72	28,3	31,2	2	
Asia Pacific	388,75	23,1	44,6	2,1	2,3		2,9
Western Europe	291,47	14	72,3	26,4	25,4	1	
Central and Eastern Europe	48,56	20,9	41,6	4,1	4	0,1	
Latin America	45,98	22,1	33	34,9	32,9		0,1
Middle East and Africa	27	31	31,3	4,2	4,3		0,2
Total	1,22129	17,1	40,4	-	-	-	-

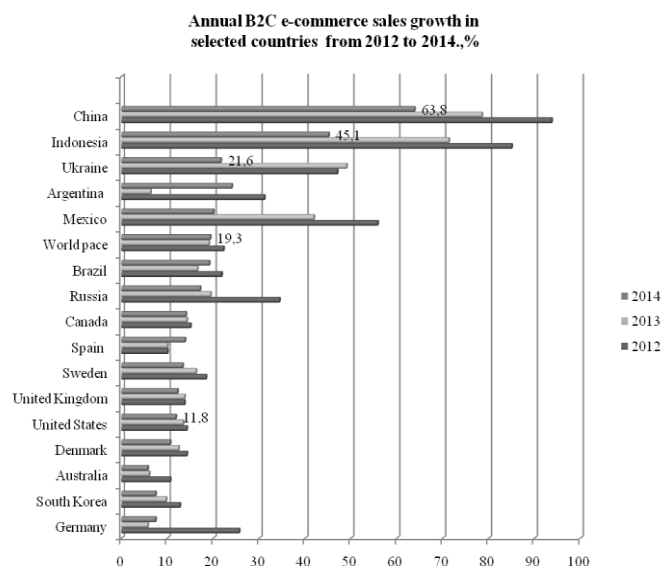


Fig. 2. Growth rates of B2C sales from 2012 to 2014, %

High growth rate at the level of 20.9% is demonstrated by Central and Eastern Europe, but it is lower than in Asia and North America (Fig. 3).

Analysis of commodity composition of e-commerce markets in Ukraine, Russia, Switzerland and the U.S. in 2013 showed disproportional distribution of sales according to segments: e-commerce market in the U.S. is well-balanced and offers a wider range of products than Ukrainian market (Fig. 4). The range of goods in Swiss e-commerce market is not wide but it is well-balanced in contrast to Ukrainian market where 90% of all orders are distributed between two main sectors.

Despite the development of e-commerce business in Ukraine, online-orders do not gain a great popularity with the population, the anticipated level in 2014 was about 3% comparing to 90% in the leading country – the U.S. What makes Ukrainian

⁴ Internet business in Ukraine. Available <http://ain.ua>

market special is that people here mostly use the Internet to learn about the goods, to know about technical specifications of the products, to read other customers' feedbacks, to compare prices and so on, and only a limited number of users place orders, that is why the level of online-shopping and the number of online buyers remain low.

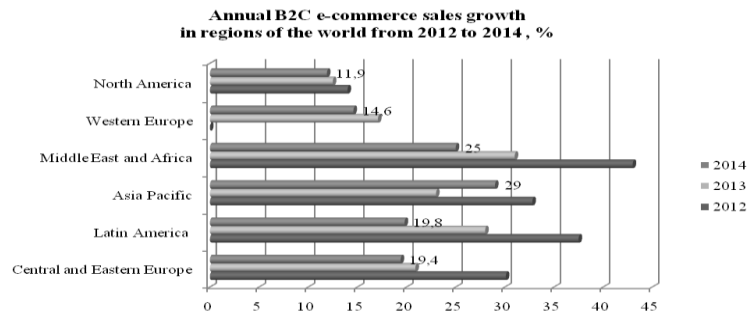


Fig. 3. Dynamics of growth rate of B2C e-commerce sales in regions from 2012 to 2014, %³



Fig. 4. The commodity structure of sales in B2C e-commerce segment in selected countries⁵.

The results of the research showed the tendency typical for the national markets of all countries – one leading company being in dominant position well ahead of its nearest competitors. Ukrainian e-commerce market is entering the phase of growth because of relatively low volumes of sales of Ukrainian companies (Fig. 5).

In spite of rapid development of e-commerce and e-business in Ukraine there are still some certain difficulties and obstacles that reduce the growth rates of online business as a whole (Table 5).

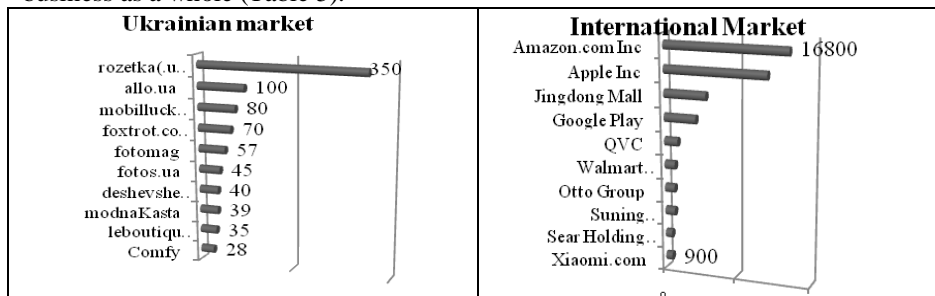


Fig. 5. Comparative analysis of the B2C e-commerce sales volumes in different countries according to investigation in 2013, mln. dollars

Table 5 Problems and prospects of e-business in Ukraine ⁵

Factor	Essence
Factors impeding the development of e-business in Ukraine	<ul style="list-style-type: none"> ❖ insufficient development of IT; ❖ limited using of IT; ❖ conservatism and distrust of innovations; ❖ low purchasing power of the population; ❖ lack of specialists; ❖ contractor's mistrust of the banking system; ❖ lack of legal regulation
Prospects for e-business in Ukraine	<ul style="list-style-type: none"> ❖ creating jobs for skilled workers; ❖ access to Western capital investment; ❖ increasing in tax revenues from the use of electronic payments
Factors accelerating development of e-business in Ukraine	<ul style="list-style-type: none"> ❖ development of electronic payment systems on the Internet; ❖ legislative regulation of the e-commerce, the legal recognition of electronic records and electronic signatures; ❖ protecting commercial information during network transmission

One of the main impacts of e-commerce activity is the formation of certain triad of consequences: product price cutting; speeding up the time and transformation of space (elimination of borders); creation of horizontal links between players and direct contact [4] (Fig. 6).

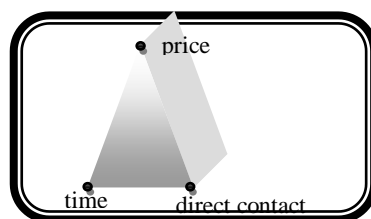


Fig. 6. The triad of e-commerce components

3. Auctions Formats

In most real markets sellers have no perfect information about the market demand, and know only about its statistical distribution. Only buyers know exactly how much product they want to buy at a definite price. Self-regulating market mechanism is not always able to disclose all information about the buyers' solvency and sellers' costs.

The research of decentralized market mechanisms allows us to determine how and why real markets collect and transmit information. Then special mechanisms for the distribution of goods are created, such as auction models.

Auctions can implement the mechanisms of transformation of private information about the value of goods for buyers into common knowledge. In turn, the rules of the auction can stimulate sellers to disclose private information about their cost of goods. Maximum purchasing capacities of the buyer and seller costs are called agents *types*.

⁵ Ukraine overview. Available www.ebrd.com/where-we-are/ukraine/overview.html

Designing economic mechanisms for auctions allows building a model of relevant institutions that determine the conditions and means of achieving the goal of the designer [Kobets, 2014]. This model is effective if it allows the planner to create incentives for the disclosure of information held by others to achieve private or public purpose.

To solve these problems auctions mechanisms are designed which motivate the agents to truthfully reveal their private information. Auctions are important for goods that have no natural market, such as bankrupt firms, mobile and radio frequencies. Here accurate information about the number of regular buyers is missing, variance of buyers' values can be very large, and pre-sale valuation and transaction costs are significant.

Operating of Internet-auction is a necessary condition for the development of e-commerce segment and its further growth grounded on [4, 12] (Fig.7).

Effective use of electronic auctions has been confirmed empirically by the most famous giants of global e-commerce such as eBay.com, Sothbys.Amazon.com Yahoo!Auctions and DigiBid.com, which actively use a similar mechanism to promote and sell products and services. Westernbid.com, lotok.com.ua, eTorg.com auctions are gaining their popularity in Ukraine. There are several types of auctions with specific methods of pricing (Table 6):

If a product is sold to the individual who values it most, the auction is efficient. Auction yielding maximum revenue to the seller is optimal [13-14].

Vickrey auction

Agents convey their true type only if it gives them maximum (expected) payoff. Revealing the type means the seller's payoff maximization and efficient allocation of resources (the buyer who values the product most receives it). Vickrey auction (sealed bid second price auction) best of existing auctions formats reveals the types of participants. True strategy is a dominant for Vickrey auction format (as opposed to the first price auction) [15]. The winner receives a payoff as the difference between his own purchase capacity and second price. So when one of the agents has a greater solvency than others, he gets a discount equal to the difference between the first and second largest bids. If Vickrey auction has several winners, then it will select one of them with equal probability.

Then there were 2 extensions of this approach: the *revelation principle*, which showed that direct mechanisms are similar to indirect ones and *implementation theory* that helps to built mechanism so that all its equilibria were optimal ones [16].

Double auction

Theory shows that double auctions, where traders (buyers and sellers) charge their prices can be effective trade institutions, where each agent has private information about his own values of goods.

With the increasing number of traders, the double auction will more effectively generalize personal information so that eventually all information is reflected in equilibrium prices (as argued Wilson). These results are consistent with F.Hayek's argument that markets efficiently summarize relevant private information.

Vickrey auction theory gained wide support from the economists; some elements of the theory have been used in the US in B2G(A) type of e-commerce in organizing the trade licenses to use national radio frequencies. The US State Treasury asked FTC to use this type of auction for revenues maximization.

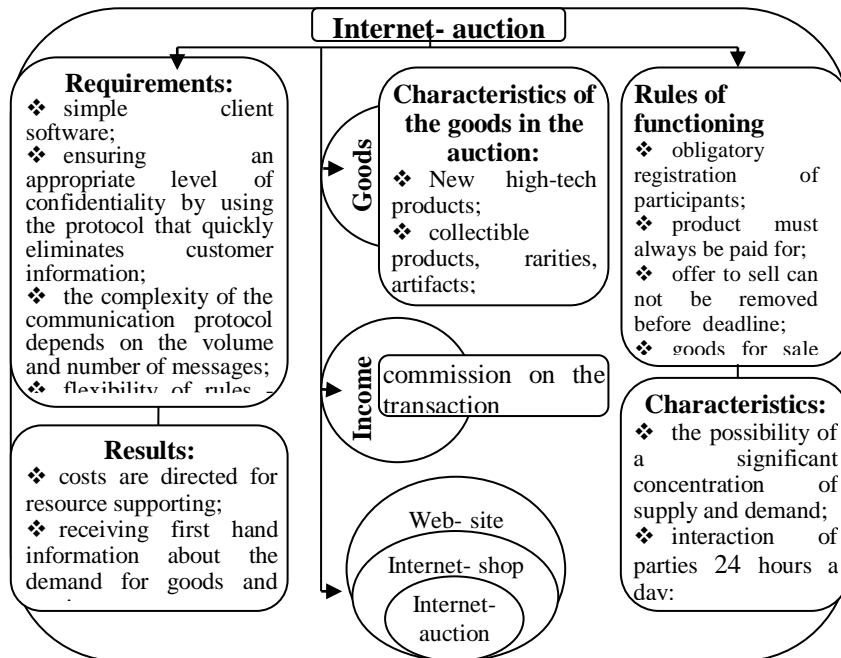


Fig. 7. The mechanisms of pricing in Internet- auctions

Table 6. Diversity of Internet - auctions

Type	Subspecies	Essence	
Order	Descending	Next bid is lower than the previous.	
	Growing	Next bid must be higher than the previous.	
According to the degree of openness	Closed	sealed bid first-price auction	This auction does not disclose the participants' offers. The buyer who offers and pays the maximum price will win.
		sealed bid second price auction	Vickrey auction means the participants don't disclose their proposals. The winner, who has offered the maximum price, pays the second after it.
	Open	English auction	The main characteristic of the auction is that buyers know about competitor's offers. The price starts from a certain minimum level mark. The winner pays the highest price.
		Dutch auction	The main characteristic of the auction is that buyers disclose their bids. The maximum price is fixed and reduced until a buyer agrees to accept it.
		Double auction	The main characteristic of the auction is that buyers and sellers disclose their bids and asks respectively. The seller and the buyer interact the same time - as a result, the equilibrium market price is fixed.

The challenges of the market mechanism require creating rules of interaction for bidders, realized by means of transactions on computer platforms with appropriately developed software and leading to economically desirable distribution of goods and payments deprived of collusion or dishonest behavior of participants.

4. Double Electronic Vickrey Auction Model

To construct the auction model, we introduce the following assumptions. Seller offers one indivisible good to N buyers, who are risk neutral. Buyer i has purchase capacity v_i , $i = 1, \dots, N$. Evaluation of solvency of buyer i is obtained from the interval $[1; 100]$ in accordance with the distribution function $F_i(v_i)$ and distribution density $f_i(v_i)$. Buyers' values of good are mutually independent. Every buyer knows his/her own value and does not know the values of other buyers. However, density distribution functions f_1, \dots, f_N are common knowledge and are known to both buyers and the seller. Although the seller is uninformed about the exact solvency value of the buyer, he knows the distribution from which each value is received. If the solvency of the buyer who wins the product is v_i , and he pays the price p , his consumer surplus equals $CS_i = v_i - p_i$. The seller's short-run profit will change when the auction format changes.

Sealed bid first-price auction

Buyers make sealed bids b_i that depend on their ability to pay v_i . Buyers' bids are considered as a strategy in the form of functions mapping their solvency in non-negative bid: $b_i \rightarrow R_+$. Expected payoff of buyer i will be:

$$CS(r; v) = F^{N-1}(r) \cdot (v - \hat{b}(r)), \quad (1)$$

where r - buyer bid, v - buyer reservation price, $F^{N-1}(r)$ - the probability that the buyer bid on the goods is the highest among all applicants. After first order condition for function maximization (1) and for conditions $F(v) = v$ and $f(v) = 1$ we get size of equilibrium bid for sealed bid first-price auction:

$$\hat{b}(v) = v - \frac{v}{N}. \quad (2)$$

So in this auction format, each buyer conceals his true solvency, relying on a lower bid level than its reservation price.

Double electronic Vickrey auction for true type's agents

Buyers will behave differently in sealed bid first price auction and Vickrey auction. First price auction offers 2 motives for buyer: (i) an incentive to rise his stake to increase his chance of winning; (ii) an incentive to reduce his bid to reduce the price he pays when winning. For Vickrey auction the second motive is not valid, because the winner pays the price which does not depend on his bid. This allows to expect aggressive competition for the good at Vickrey auction. Let B be the second largest bid at the auction, then a winner disclosing his reservation price will win payoff $CS(v) = v - B$.

Suppose that M risk neutral sellers operate in the market. The cost distributions for sellers are obtained from the interval $[1; 100]$ in accordance with the known distribution functions. Sellers make sealed asks a_i that depend on their costs c_i . If the seller's cost is c_i , and he gets the price p , his producer surplus (profit) is $PS_i = p_i - c_i$.

Consider our software module for electronic Vickrey auction in Fig. 8.

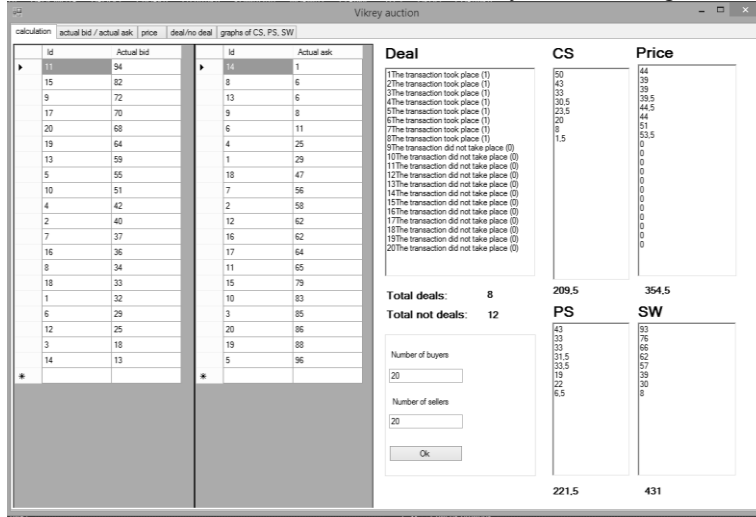


Fig. 8. Double electronic Vickrey auction for true type's agents

In general the number of buyers and sellers may differ $N \neq M$. The buyers' ability to pay is ordered from maximum to minimum and for sellers it is from minimum to maximum.

The agreement between agents (deal = 1) occurs when a price offered by buyer is not below the price set by the seller ($b(v_i) \geq a(c_i)$), otherwise the agents refuse the transaction (deal = 0). The price for each transaction for each pair of buyer and seller is set at the average level:

$$P_i = \frac{v_{i+1} + c_{i+1}}{2}, \quad (3)$$

The auction continues until the highest price offered by a buyer will be lower than the minimum price charged by the seller: $b(v_i) < a(c_i)$ (Fig. 9). After each transaction the benefits of buyers are defined in the form of consumer surplus CS and sellers gains – as producer surplus PS . The sum of consumer and producer surplus forms social welfare SW as efficiency indicator of Vickrey auction format (Fig. 10).

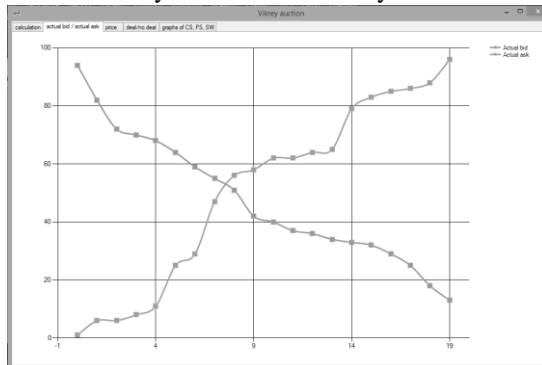


Fig. 9. Bids and asks distribution at double electronic Vickrey auction for true type's agents

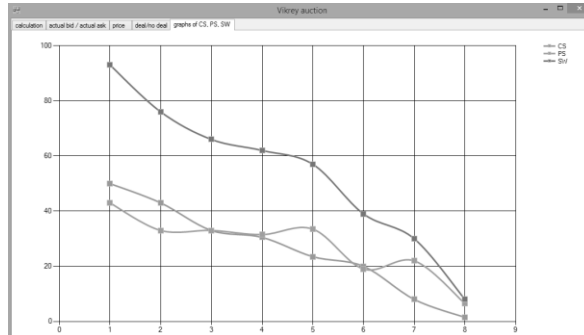


Fig. 10. Dynamics of consumer and producer surplus, social welfare at double electronic Vickrey auction for true type's agents

Fig. 10 shows that functions CS , PS and SW are decreasing in the number of transactions, because during each round of the auction buyers with the highest ability to pay and sellers with lowest cost will benefit. In each round of double Vickrey auction the price of good at first increases and then remains constant, then begins to decrease until it reaches zero (Fig. 11).

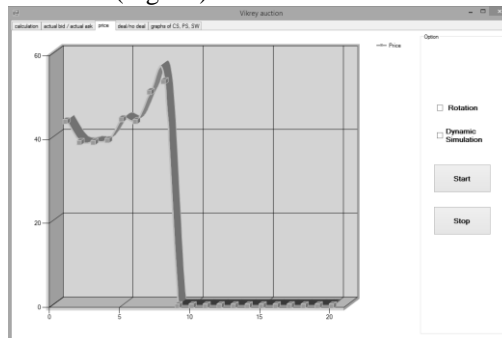


Fig. 11. Price dynamics in double electronic Vickrey auction for true type's agents

Vickrey auction agents' underestimating their ability to pay or overestimating their costs will result in reducing consumer surplus, producer surplus and social welfare. As soon as agents with larger ability to pay and lower cost can not deal in auction, they will discover during few periods that revealing their true type will allow them to maximize their own surplus.

Proposed model of double electronic Vickrey auction for true type's agents is described by the following algorithm by the means of C#:

```
public void Deal(Auction auction)
{
    int count_take = 0;
    int count_not_take = 0;
    string pattern_one = "The transaction took place (1)";
    string pattern_second = "The transaction did not take place (0)";
    for (int i = 0; i < auction.Customer_auction.Count; i++)
    {
        if (auction.Customer_auction[i].Bit >=
            auction.Seller_auction[i].Ask)
    }
}
```

```

{count_take += 1;
richTextBox5.Text +=i+1+pattern_one + "\n";}
else
{count_not_take += 1;
richTextBox5.Text +=i+1+patter_second + "\n";}}}
publicList<float> Price(Auction auction)
{intprice_did_not = 0;
float average = 0f;
for(inti=0;i<auction.Seller_auction.Count;i++)
{if (auction.Customer_auction[i].Bit >=
auction.Seller_auction[i].Ask)
{average = (float)(auction.Customer_auction[i+1].Bit +
auction.Seller_auction[i+1].Ask) / 2;
averageList.Add(average);
this.richTextBox3.Text += average.ToString()+"\n";}
else if (auction.Customer_auction[i].Bit <=
auction.Seller_auction[i].Ask)
this.richTextBox3.Text += price_did_not.ToString()+"\n";
if (i + 1 == auction.Customer_auction.Count)
break;}
returnaverageList;}

```

Double electronic Vickrey auction for hidden type's agents

During the sale of goods through the auction mechanism a buyer tends to undercharge his own ability, while the sellers tend to overvalue their own costs. So electronic Vickrey auction for true type's agents is less likely than e-auction for hidden type's agents. In theory double Vickrey auction motivates participants to fully disclose their types, because they pay the second largest cost. However, the proposed here new model of double Vickrey auction for hidden type's agents demonstrated that some of agents can hide their true type, despite the existing incentives for disclosure. According to traditional models of double Vickrey auction agent type is disclosed completely.

Consider software module 'Vickrey auction' for double electronic Vickrey auction for hidden type's agents (Fig. 12).

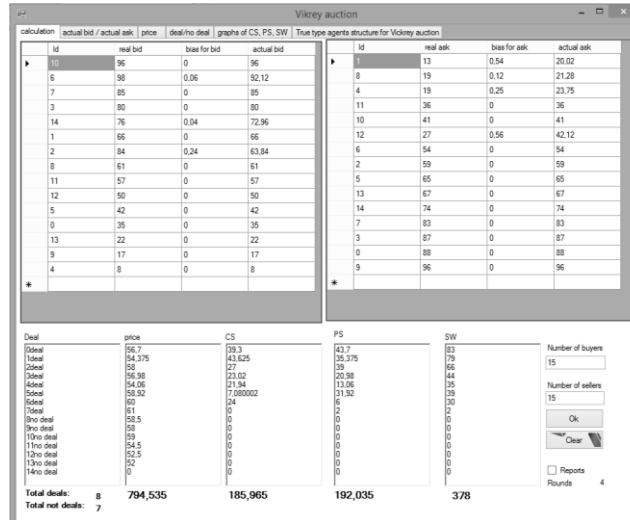


Fig. 12. Double electronic Vickrey auction for hidden type's agents

In this module first we enter *Numbers of buyers* and *Numbers of sellers*. Consider equal numbers of buyers (15) and sellers (15). After entering the data into the appropriate field (Fig. 12), we obtain buyers' real ability to pay *real bid* (as a random number between 1 and 100) and deviation *bias for bid* (as a random number in the interval (0, 1)), which reduces percent of real solvency and gives us actual ability to pay *actual bid*. Therefore the relationship between indicators for buyers looks like: $actual\ bid = real\ bid * (1 - bias\ for\ bid)$. Similarly, we obtain the real costs of seller *real ask* and deviation *bias for ask*, percent of which overstates the actual costs, and reported expenses *actual ask* are received. Thus, the relationship between indicators for sellers is as follows: $actual\ ask = real\ ask * (1 + bias\ for\ ask)$.

After that reported solvency *actual bid* is arranged in descending order, and reported costs *actual ask* is arranged in ascending order. Then pair-wise comparison takes place between the buyer with the highest ability to pay and seller with lowest cost. If $b_i \geq a_i$ then there is an agreement (deal=1) between buyer i and seller i at the price of $P_i = (b_{i+1} + a_{i+1})/2$. For deal i consumer surplus of buyer is $CS_i = b_i - P_i$, producer surplus is $PS_i = P_i - a_i$, social welfare is $SW_i = CS_i + PS_i$. Otherwise, the agreement between the buyer and the seller does not take place (deal=0). Buyers and sellers who do not deal have the incentive to reveal their true types (solvencies or costs).

Proposed model of double electronic Vickrey auction for hidden type's agents is described by the following algorithm by the means of C#:

```
public List<bool> Deal(Auction auct, List<bool> DealList)
{
    int countdeal = 0;
    int countnodeal = 0;
    for (inti = 0; i < auct.Customer_auction.Count; i++)
    {
        if
        (auct.Customer_auction[i].ActualBid >= auct.Seller_auction[
        i].ActualSell)
    }
}
```

```

{DealList.Add(true);
countdeal++;}
else
{DealList.Add(false);
countnodeal++;}}
returnDealList;}
publicList<float> PS(Auctionauc, List<float>ListPs,
List<float>ListPrice)
{float temp;
floatps;
for (inti = 0; i<auc.Customer_auction.Count;i++ )
{temp = ListPrice[i] - auc.Seller_auction[i].ActualSell;
if(temp>0 &&
auc.Customer_auction[i].ActualBid>auc.Seller_auction[i].ActualSell)
{ps = ListPrice[i] - auc.Seller_auction[i].Ask;
ListPs.Add(ps);}
else
{ps = 0;
ListPs.Add(ps);}}
returnListPs;}

```

But the agreement between buyers and sellers is not completed. Those buyers and sellers who have no deals may revise their bids, that is to reveal their real types. They have an incentive to do so because they haven't got the desired unit of good. After revealing their true type their deviation will be zero: *bias for ask = 0, bias for bid = 0*. Further agreements will be revised to reflect the new bids. Then those agents who in the first round were able to buy (sell) goods at their bid and concealed their true type in the second round may lose this opportunity. Then they will get an incentive to disclose their true types. This procedure continues until the final round yields no changes in the redistribution of goods compared to the previous round. It means that the double Vickrey auction for hidden type's agents is completed.

Fig. 12 demonstrates that the buyers' solvency of 2, 6 and 14 remains hidden while the remaining buyers fully reveal their types. Similarly, sellers 1, 4, 8 and 12 did not disclose their true costs, while the rest of the sellers do it. Thus our Vickrey auction model compared with other auctions formats reveals some true types of agents, but this auction format does not motivate all to do as stated in classical Vickrey auction model. In proposed auction model low cost sellers and high solvency buyers can conceal their true types.

For our example 80% of buyers and 73% of sellers reveal their types (i.e. 76% of all traders). 20% of buyers and 27% of sellers conceal their types (i.e. 24% of all traders).

5. Conclusions

To improve e-commerce efficiency there are special mechanisms for distribution of goods and payments such as auctions models that are designed to convert private information about the value of goods for buyers and sellers into common knowledge.

Vickrey auction (sealed bid second price auction) best of the existing auction formats reveals the types of participants. Software modules for dynamic double electronic Vickrey auction were first developed to generalize this auction format. It is determined that in double electronic Vickrey auction incentives are created for *most* buyers and sellers to reveal their true solvencies and costs. But for *some* buyers and sellers these incentives are not enough to disclose their types, which reduces the efficiency of the auction format. The designed program of dynamic double electronic Vickrey auction is closest to perfect competition market and in terms of social welfare ahead of alternative auction formats such as first price auction, English and Dutch auctions, in which the vast majority of agents are hiding and not revealing their types.

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