

УДК: 338.27

MODELLING OF AUTMOBILE BUILDING ENTERPRISES' INNOVATIONS DIFFUSION

Yashkina O.I. PhD, senior lecturer

Odessa National Politechnic University, Odessa, Ukraine

Яшкіна О.І. Моделювання дифузії інновацій автомобілебудівних підприємств.

У статті проаналізовано збут легкових автомобілів та виявлено фактори інноваційної діяльності виробників та дилерів, які впливають на нього. За результатами дослідження виявлено три види попиту на легкові автомобілі: класичний, новорічний та осінній. Отримано прогнози продажу певних популярних в Україні марок легкових автомобілів на 2014 рік.

Ключові слова: дифузія інновацій, математичне моделювання, сезонність попиту, декомпозиція часового ряду, автомобілебудівні підприємства

Яшкіна О.И. Моделирование диффузии инноваций автомобилестроительных предприятий.

В статье проанализированы продажи легковых автомобилей и выявлены факторы инновационной деятельности производителей и дилеров, которые влияют на них. По результатам исследования выявлено три вида спроса на легковые автомобили: классический, новогодний и осенний. Получены прогнозы продаж определенных популярных в Украине марок легковых автомобилей на 2014 год.

Ключевые слова: диффузия инноваций, математическое моделирование, сезонность спроса, декомпозиция временного ряда, автомобилестроительные предприятия

Yashkina O.I. Modeling of auto companies' innovations diffusion.

The paper analyzes passenger cars sales and identifies factors of manufacturers' and dealers' innovation activity that affect them. The study identifies three types of demand for cars: classic, Christmas and autumn. Sales forecasts for certain popular brands of cars Ukraine for 2014 are obtained.

Keywords: diffusion of innovations, mathematical modeling, seasonality of demand, time series decomposition, automakers

Predicting of the market conditions' future trends, with the demand for products, with consumer preferences is an important task and a big challenge for marketing experts. The market usually develops spontaneously and unpredictably. There are factors that can not be predicted. How will they act, what impact should we expect from them – this question has no right answer in advance.

But the study of trends that have already formed in the market allows us to construct models. The situation in the domestic automotive market is not optimistic in recent years. The demand for domestic cars does not satisfy neither the manufacturer nor the dealer. Therefore, there are protective mechanisms of Ukrainian manufacturers, as high duties on imported cars and utilization fee. Mathematical tools for domestic cars' demand prediction should provide instruments for sales and promotion control.

Analysis of recent research and publications

In today's publications automotive enterprises' management strategies are more analyzed. Choosing a strategy is based on a policy of protectionism [3], or under the crisis [8], or with the use of modern technology [9]. Current trends in demand for passenger cars in Ukraine, and domestic cars' export potential considered in works of: Kryvokon O.H., Bondarenko A.I. and Omelchenko O.V. [5, 6], but the material is too general and does not apply to specific car brands.

Unsolved aspects of the problem

Current passenger cars market's development trends, changes in consumers' demand and in their preferences bring corrective amendments to the classical theory of product life cycle. It significantly reduces at high market dynamics. This situation requires a detailed study of fluctuations in demand for passenger cars and its impact factors.

The purpose of the article is the to classify the demand for passenger cars basing on innovation policy of the manufacturer.

The main material of the research

The most famous domestic automobile manufacturer with complete production cycle is PJSC "Zaporiz'kyj Automobile Building Plant". Zaporiz'kyj Automobile Building Plant produces five models of passenger cars under the brand ZAZ: ZAZVida ZAZ Forza, ZAZ Sens, ZAZ Lanos, ZAZ LanosPick-up.

Let us consider the dynamics of sales of these brands in Ukraine (Fig. 1-3) [1].

As seen in Figures 1-3, the dynamics of Ukrainian cars' sales is unstable. It is characterized by sharp

fluctuations in demand, which are connected with the seasonal component, as well as with the commodity and price innovations of manufacturers and dealers.

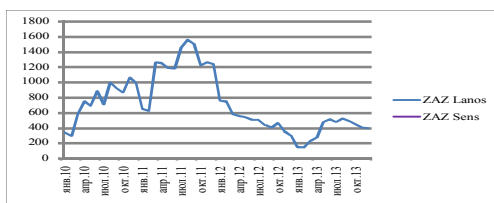


Fig. 1. Dynamics of ZAZ Sens and ZAZ Lanos sales, pc.

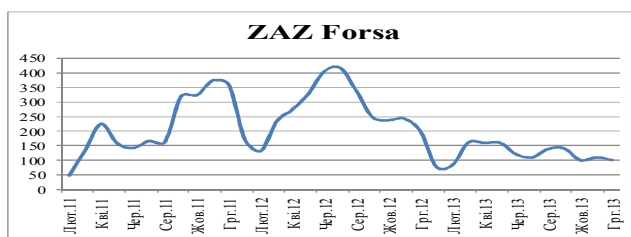


Fig. 2. Dynamics of ZAZ Forsa sales, pc.

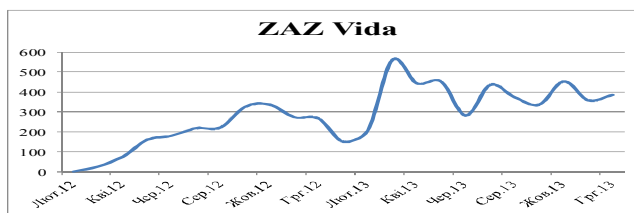


Fig. 3. Dynamics of ZAZ Vida sales, pc.

In 2013 the sales leader (ZAZ Lanos) gave way to his "brother" – ZAZ Sens. From 2006 to 2011, ZAZ Lanos according to the results Of Ukrainian automobile rating "Autorating" held the title of "absolute leader in sales" [7]. It is likely, that "crazy" popularity of ZAZ Sens is because of its appearance in hatchback (February 2012). As well as fact that the company and dealers hold the lowest price for this

brand in the class C (up to 100 thousand UAH) – 56900 UAH.

The most popular car models in Ukraine in 2013 were (table 1.):

As can be seen from Table 1, ZAZ Lanos and ZAZ Vida are in the top ten sales leaders. ZAZ Vida started on the market in February 2012 and thanks to its modern design, high technical characteristics and proper promotion over 2 years entered the top ten.

Table 1. Bestsellers in Ukraine in 2013 [according to 1]

Place	Name	The sales volume, pc
1	ZAZ Sens	6611
2	HyundaiAccent	5611
3	Geely CK	4961
4	GeelyEmgrandEC7	4673
5	Geely MK	4600
6	KIA Rio	5463
7	RenaultLogan	4495
8	VolkswagenPolo	4486
9	ZAZ Vida	4027
10	ZAZ Lanos	3947

ZAZ Forsa entered the Ukrainian market in February 2011, and in February 2012 received the title of "best affordable car for 2011". In 2011, Forsa's sales amounted to 2433 units (19 in the rating), and in 2012 – 3257 units (16 in the rating). But after two years of popularity "wave" the attention of consumers to the Forsa brand rapidly fell. Its sales in 2013 decreased by more than 2 times compared to previous years – 1353 units.

Innovative automotive products have different trends in diffusion. To get more information, to obtain fundamental models of diffusion of innovations in

passenger car market let us consider the sales' dynamics of other car brands.

The demand of Ukrainian car lovers for Geely cars in 2013 increased by 35.8% compared to 2012. It is the only manufacturer of top ten, which reached a significant increase in sales. Chinese cars coming off the assembly line of Kremenchug car assembly plant are aimed to meet the needs of consumers in all vehicle classes – from budget Geely CK (Figure 4) to conditionally luxury GeelyEmgrandEC7 (Fig. 5).

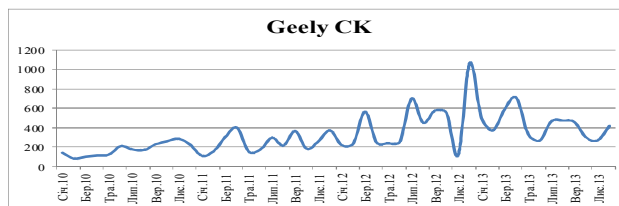


Fig. 4. Dynamics of sales Geely CK, units

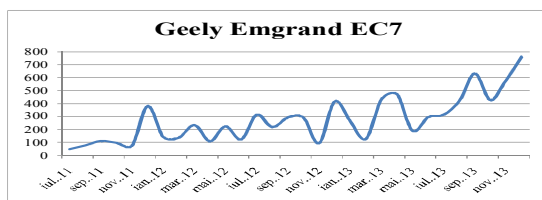


Fig. 5. Dynamics of GeelyEmgrandEC7 sales, units

Pricing policy of Geely cars' manufacturer and dealers is directed at market capturing. Thus, the manufacturer keeps the price of 55900 UAH on the budget car Geely SC, moreover, Geely prices have not changed even with the introduction of utilization fee. This price policy allows to maintain sales in the growing trend.

GeelyEmgrandEC7 is the crossover with a 1.8 liter engine, costing from 100 thousand UAH. After two and a half years of the model's emergence the trust of Ukrainian people increased, and in December 2013 (the "dead" season) sales reached "historical maximum" – 761 units.

From this example it is possible to get a conclusion about the high price elasticity of demand of domestic consumers for passenger cars. But let me consider a few more examples. In April 2011, the Ukrainian market was struck by a new design of the popular Hyundai sedan. South Korean car got aggressive traits and due to the new exterior increased Accent sales in several times (Fig. 6). The market's attention to distinct Hyundai cars' design does not decrease over two years, and in April 2013 Accent sales reached 948 units.

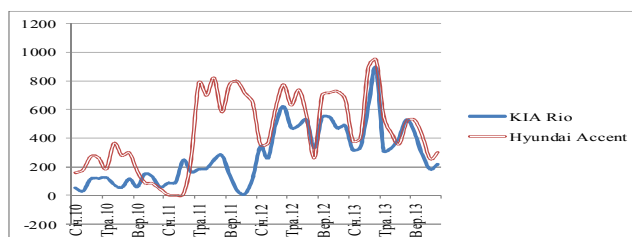


Fig. 6. Dynamics of HyundaiAccent and Kia Rio sales

The closest Hyundai's competitor is the KIA, which is also South Korean company, in January 2012, it radically changed the design of the popular sedan Rio, it became similar to the "aggressive" Accent. The market immediately reacted to more than double sales (Figure 6). In 2013 these brands had identical sales. So radical design changes result in "jumps" of demand, much higher than thanks to the price discount.

Let us consider a few more examples. A popular in Europe passenger car Ford Fiesta (second highest rating in 2013) is not included in the most popular cars top ten in Ukraine. Its sales in Ukraine are stable and have a small increasing trend (Fig. 7).

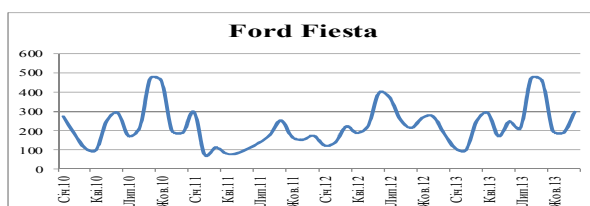


Fig. 7. Dynamics of FordFiesta sales, units

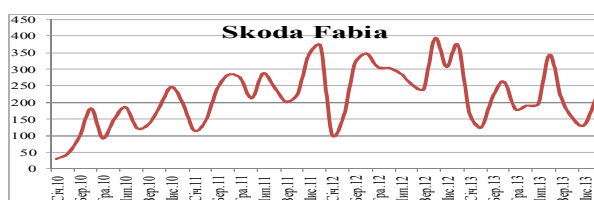


Fig. 8. Dynamics of SkodaFabia sales, units

Czech car manufacturer Skoda is now a part of German concern Volkswagen. Therefore Ukrainian consumers prefer European car quality. Affordable price for Skoda Fabia cars, their efficiency and technological equipment have made them popular among young people. In 2012, the Fabia has undergone some improvements in design, which led to a slight increase in demand, but later, in 2013,




Skoda Fabia was not improved either in technology or in the design or in bright promotion so sales declined even compared to 2011 year.

According to given examples, we can form the table showing the impact of changes in design, technology and prices on demand. (Table 2)

Table 2. The influence of technological, design and price changes for automotive demand

№	Brand	Demand	Design improvement	Technological improvement	Pricing policy	Result
1	ZAZ Sens		In 2012 came in hatchback	minor improvements	one of the lowest prices - from UAH 56900.	leader in sales in 2013
2	ZAZ Vida		entered the market in February 2012 with a modern design	modern technological weapons	86-106 thousand UAH	in two years entered the top ten
3	ZAZ Lanos		minor	minor	70-90 thousand UAH	rapid fall from the first position in 2006-2011 to the 10th in 2013
4	Geely CK		minor	minor	one of the lowest - from UAH 55900	third place in sales in 2013

Table 2. continuation

5	GeelyEmgrandEC7		entered the market in July 2011 in a modern style	modern technological weapons	100-120 thousand UAH	fourth place in the sales rating in 2013
6	Geely MK		entered the market in March 2012 with the modern design	modern technological weapons	76-91 thousand UAH	Over less than two years, took fifth place in the top five
7	HyundaiAccent		radical redesign in 2011	minor improvements	132-181 thousand UAH	second place in the rating in 2013
8	KIA Rio		radical redesign in 2012	minor improvements	146-171 thousand UAH	rapid sales growth in the years 2012-2013
9	FordFiesta		slight improvement in 2012	significant improvement in 2013	110-160 thousand UAH	steady growth in sales
10	SkodaFabia		slight improvement in 2012	minor	108-170 thousand UAH	decline in sales in 2013

The demand for cars is seasonal. Using the method of "moving average ratio" (decomposition of time series) we can calculate seasonal influence on it. In Table 3 there are seasonal indices that were calculated according to the monthly sales of discussed

earlier car brands. For the calculation we have chosen the brands, over the sale of which there is a data for four years – from 2010 to 2013. For lesser period the calculations are not sufficiently reliable.

Table 3. Seasonal indexes of car sales

	KIA Rio	SkodaFabia	HyundaiAccent	ZAZ Lanos	ZAZ Sens	Geely CK	FordFiesta
January	0,81	0,55	0,40	0,61	0,50	0,73	0,85
February	0,71	0,59	0,43	0,61	0,51	0,71	0,48
March	1,44	1,05	0,84	0,84	1,24	1,36	0,88
April	1,54	1,21	1,20	0,88	1,16	1,26	0,83
May	1,02	1,04	1,30	1,06	1,11	0,66	0,73
June	1,05	0,97	1,18	1,10	1,06	0,64	1,13
July	1,09	1,16	1,32	1,06	1,46	1,25	1,07
August	1,17	0,90	1,05	1,18	0,92	0,92	1,08
September	0,82	0,83	1,18	1,13	0,72	1,25	1,54
October	0,87	1,14	1,00	1,10	0,76	1,01	1,38
November	0,70	1,28	0,91	1,11	0,68	0,81	0,97
December	0,64	1,30	0,76	1,03	0,72	1,46	0,88

Seasonality of demand for new cars has a different character. In all cases there is a sharp drop in demand in January and February, then – spring "boom" and then there are very different trends.

We have identified three types of seasonal demand for cars:

- Classical;
- Christmas;
- Autumnal.

Classic demand, in our view, is own by the following car brands: KIA Rio, Hyundai Accent and ZAZ Sens (Fig. 9). The maximum sales in this case occur in the spring months, than there may be also a "summer wave". This schedule of seasonal indexes characterizes the demand for popular cars. Consumers are buying novelties in the sales season, but not during closeouts prices.

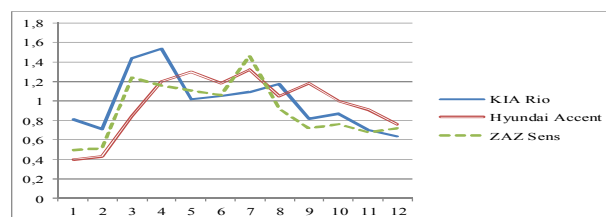


Fig. 9. Seasonal indexes of classic car demand

Demand that we called "Christmas" present trends in selling such brands of cars like Skoda Fabia and Geely CK (Fig. 10). During Christmas Sale seasonal indices of these models reached 1.3 and 1.46, so the sales in December exceeded the average for the year by 30-46%. Spring demand for these brands is also

high, but does not reach the level of December. This graph, in our opinion, characterizes the demand of maximum price gains. This car attracts consumers by the discount price, not by specification or design.

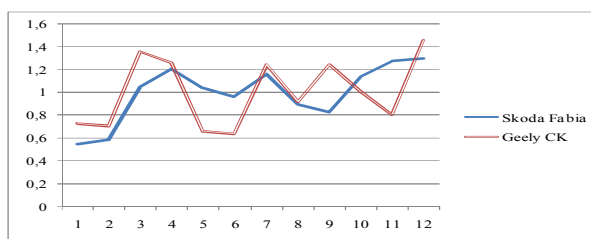


Fig. 11. Seasonal indexes of maximum "autumnal" demand

"Peak" seasonal indexes in the third group go through late summer – early autumn. For example, the maximum sales of the Ford Fiesta are in September (index 1.54) and in October (index 1.38), and of the Lanos – August (index 1.18) and September (index 1.13). During this period, car dealers are beginning to offer discounts, but not as significant as in the new year period. In our view, such a demand characterizes discerning consumers

who are not in a hurry to purchase car in the spring season, but expect discounts of the season, but not final closeouts.

By dividing the outgoing sales data of car brands in the seasonal indexes from the table 3, and using tabular processor Excel's service "Data Analysis", we got the equation of the linear trends in car sales for all brands considered (Table 4).

Table 4. Linear trends in car sales

Car brand	The equation of the trend	Interpretation
Classical demand		
KIA Rio	$\hat{Y} = 31,09 + 10,32t$	Expected sales excluding season – 10 cars per month in average
Hyundai Accent	$\hat{Y} = 252,61 + 9,31t$	Expected sales excluding season – 9 cars per month in average
3A3 Sens	$\hat{Y} = -108,66 + 19,69t$	Expected sales excluding season – 20 cars per month in average
Christmas demand		
Skoda Fabia	$\hat{Y} = 161,51 + 2,22t$	Expected sales excluding season – 2 cars per month in average
Geely CK	$\hat{Y} = 142,81 + 7,37t$	Expected sales excluding season – 7 cars per month in average
"Autumnal" demand		
Ford Fiesta	$\hat{Y} = 206,24 + 0,81t$	Expected sales excluding season – 1 car per month in average
Lanos	$\hat{Y} = 1078,34 - 14,42t$	Expected sales excluding season – 14 cars per month in average

The most promising group of cars is classic demand type. Sales growth excluding seasonality is expected from 9 to 20 cars in a month. In the second group – Christmas demand – there are less optimistic forecasts – from 2 to 7 cars per month excluding seasonal. In the third group – the "autumnal" demand – there are the most pessimistic predictions – increasing demand for one car per month, or a decrease of 14 cars.

According to the obtained trends for each model we can construct forecasts for the trend (excluding seasonality), and also multiplying the trend to

seasonal indexes (including seasonality). We built four forecasts (Table 5).

For example, for the popular Hyundai Accent and ZAZ Sens the 2014 forecasts, based on seasonality, are quite optimistic (Fig. 12, 13).

Noticeable difference between the forecasts and initial data on the prehistory interval is due to the sharp "jumps" of demand in early 2011 in the Hyundai Accent model and in early 2012 in the ZAZ Sens model.

In the more stable cases forecasts are usually almost identical to the original data on the prehistory period.

Table 5 Forecasts based on seasonality for certain vehicle models, units

	Hyundai Accent	ZAZ Sens	Geely CK	Ford Fiesta
Jan.14	284	428	365	209
Feb.14	309	447	361	118
Mar.14	611	1110	701	218
Apr.14	884	1062	658	206
May 14	970	1038	350	182
Jun.14	891	1012	344	282
Jul.14	1009	1422	680	268
Aug.14	813	914	507	272
Sep.14	924	730	699	389
Oct.14	793	785	572	349
Nov.14	730	716	465	246
Dec.14	617	772	848	224

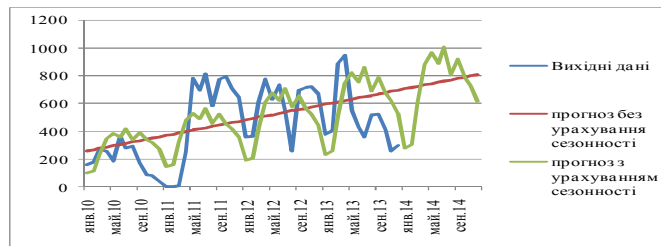


Fig. 12. Initial data and forecast for Hyundai Accent

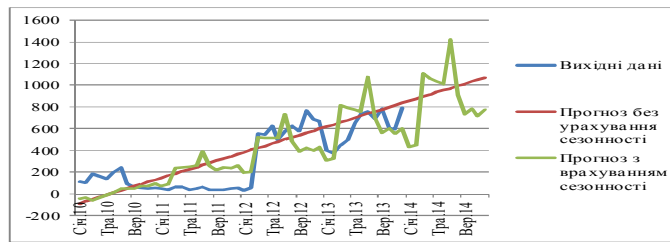


Fig. 13. Initial data and forecast for ZAZ Sens

Thus, in the Ford Fiesta we can see more accurate model, but the rapid decline in sales in 2011 affected the fluctuation in the direction of reduction (Fig. 14).

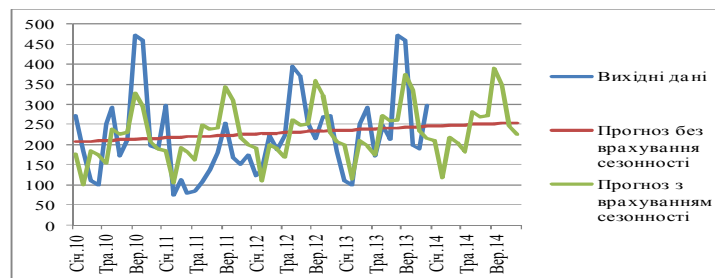


Fig. 14. Initial data and forecast for FordFiesta

The most accurate predictions, in our opinion, were obtained by decomposition of the time series for GeelyCK, showing a steady increase in demand since 2010. In Fig.15 it is noticeable that the forecast for the

prehistory period repeats the output data's fluctuation exactly. Therefore, we can assume that the prediction in this case is also the most accurate of all the above examples.

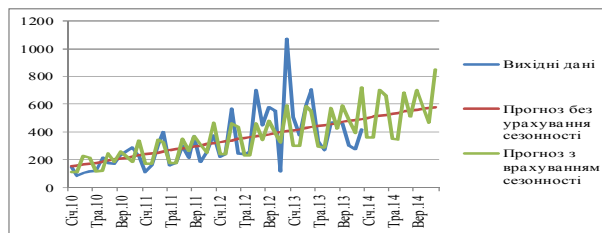


Fig. 15. Initial data and forecast for GeelyCK

Conclusions

The tendencies can be considered by dealers and manufacturers in car sales and production planning, in the formation of communication and marketing policy, and most importantly, in the development of

strategies for innovation in design and technology. The demand of cars is affected mostly by successful design factor; the low price is on second place. Considering the influence of these factors on demand manufacturer can plan sales volume.

References:

1. Автопортал [Електронний ресурс]. Режим доступу: <http://autoportal.ua/rating.html>.
2. Асоціація автопроизводителей України [Електронний ресурс] «УкрАвтопром». Режим доступу: <http://ukrauto.com.ua>.
3. Гапотченко Катерина Володимирівна. Управління підприємствами автомобілебудівної промисловості України в умовах протекціонізму: дисертація канд. екон. наук: 08.06.01 / Українська академія зовнішньої торгівлі. – К., 2003.
4. Кишун В.А. Виробництво легкових автомобілів: світові та вітчизняні тенденції / В.А. Кишун // Луцький національний технічний університет: зб. наук. праць. Електронне наукове видання. – 2003. – № 13. – С. 137 – 145
5. Кривоконь О.Г. Передумови та перспективи розвитку автомобілебудівної галузі в Україні / О.Г. Кривоконь, А.І. Бондаренко // Восточно-Европейский журнал передовых технологий, 2011. – № 6/2(54). – С. 46-50.
6. Омельченко А.В. Визначення основних напрямків розвитку автомобільного транспорту на довгострокову перспективу / А.В. Омельченко // Вісник Національного транспортного університету. – 2008. – № 17, Ч. 1. – С. 71 – 73.
7. Офіційний сайт ЗАТ «Запорізький автомобілебудівний завод». [Електронний ресурс]. Режим доступу до сайту: <http://www.zaz.ua/news/zaz-landos---%C2%ABabcoljutnyj-lider-prodazh%C2%BB-2011-hoda.html>
8. Стернюк О.Б. Особливості асортиментної політики автомобілебудівного підприємства в умовах кризи / О.Б. Стернюк // Проблеми економіки та управління №640. – Л. : Вид-во Нац. ун-ту «Львів. Політехніка», 2009. - С. 400-406.
9. Холодный Ю.Ф. Оптимизация производства автомобилестроительных предприятий с применением современных технологий / Ю.Ф. Холодный, А.И. Богдан, В.Ю. Холодный // Вісник КДПУ імені Михайла Остроградського. Транспорт. Дорожні та будівельні машини. – 2008. – № 6 (53), Ч.1. – С. 98 – 101.

Надано до редакції 28.01.2014

Яшкіна Оксана Іванівна / Oksana I. Yashkina
 nomer27@ukr.net

Посилання на статтю / Reference a Journal Article:

Modeling of auto companies' innovations diffusion [Електронний ресурс] / Yashkina O.I. // Економіка: реалії часу. Науковий журнал. – 2014. – № 1 (11). – С. 147-154. – Режим доступу до журн.: <http://economics.opu.ua/files/archive/2014/n1.html>