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USE OF PANEL DATA IN FUNCTION OF MARKET RESEARCH OF NON-WOOD FOREST PRODUCTS IN SERBIA

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ABSTRACT

In the context of market research, special attention is paid to the analysis of data based on time series. In this research the focus is on the panel analysis. The survey was conducted in Central Serbia within the companies engaged in purchasing, processing and sales of non-wood forest products (NWFPs). The aim of the research was to investigate the influence of independent variables (placement on the domestic market, export and sales prices of NWFPs) on the dependent variable – purchase of raw products. The purpose of the research was to emphasize the importance of certain factors that influence the purchase of raw materials. The subjects of research were: companies operating on the territory of central Serbia, purchase quantity, placement on the domestic market and export, as well as the prices of final products.

Keywords: panel data, Central Serbia, enterprises, non-wood forest products

INTRODUCTION

With the development and modernization of computer technology a significant progress has taken place in the development of sophisticated tools for more accurate analysis. This is particularly the case in the area of statistical and econometric research. Econometrics is focused on developing statistical methods for testing relationships between economic sizes, forecasting of economic variables, testing economic theories, etc. (Wooldridge, 2003). Application of the econometric methods is observed in most industries, especially in applied economics. In this sense, the analysis based on time series is an unavoidable component of most economically oriented investigations. Similarly, the analyses based on panel data have become more important.

According to the types of data, there are different methods for the analysis of cross-sectional data, time series, or panel (Dragutinović-Mitrović and Jovičić, 2011). The subject of comparative cross-sectional analysis is observation unit at one point. In analysing data, it is not necessary to take into account a sequence of observation units. However, the restriction is reflected in the inability to test the interdependence between the observation units. Time series are composed of observations of one or more variables over the time. As time is an important component in the data analysis, it is necessary to take into account the sequence of observations. Specifically, these data take into account the same unit of observation over time. Series of panel data is basically a combination of comparative data and time series (Jovičić, 2010).

Using panel data, we are able to look at the structure (heterogeneity) of the observation unit, as well as changes in the structure over time. Application of panel data in research is becoming increasingly important, not only because of the precision of the estimate (Cameron and Trivedi, 2005), but also possibility to

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use short time series. This is particularly important in the case of empirical research. This primarily refers to macroeconomic research, which is difficult to establish comparable time series due to various methodological approaches. In addition, panel models can give an answer to a broader range of issues than it would be possible with both time series or cross-sectional analyses (Brooks, 2008).

Series of panel data, which contain the data for all observation units at all time points are called balanced, *i.e.*, complete panel series. In this particular example, this was the case, because the data were completed. However, in practice it is often the case when information is missing and these are unbalanced panel series (Croissant and Millo, 2012). In order to overcome the problems caused by the imbalance of data, modifications of standard econometric methods are developed. They are intended for the evaluation of unbalanced panel models. In this sense, the use of the programming language R provides an adequate platform for conducting analysis based on panel data. This is intended to become two-dimensional in approach.

MATERIALS AND METHODS

The survey covered an area of Central Serbia and 30 enterprises engaged in purchasing, processing and sale of NWFPs. Collected data were related to purchase, placement on the domestic market, export and selling prices of certain types of NWFPs. The period 2006–2013 was analysed.

The aim of the research was to investigate the influence of independent variables (placement on the domestic market, export and sales prices of NWFPs) on the dependent variable – purchase of raw products.

Because there were no time series longer than 5 years, the analysis based on panel series is estimated as adequate in the present study. On the other hand, this methodological approach is suitable when talking about market research, in general.

Variable types that are taken into consideration (purchase, placement on the domestic market, export and selling prices of certain types of NWFPs) are significant if we analyse the market of this product category.

In the research lagged value of the purchase was used. This was done in such a way that the effects of prices, placement on the domestic market and export on the quantity of purchase of raw products were observed in the coming year of the analysed interval. Purchase was analysed as a dependent variable (Y), while the independent variables were: placement on the domestic market (X_1), export (X_2) and prices (X_3). Practically, the purchase of NWFPs, as a dependent variable, in the first year of the interval was labeled as 0 (Table 1). The reason for this is that the effects of the placement on the domestic market, export and price (independent variables X_1, X_2 and X_3) on the amount of purchase were not expected before next year. In this sense, in the initial year of the purchase, the value of the purchase equalled 0.

In the analysis the statistical program R, and package "plm" were used. Plm is used for evaluating the

Table 1. Panel data

Products	Year	Y	X_1	X_2	X_3
		purchase, t	placement to domestic market, t	export, t	prices, RSD
1	2	3	4	5	6
Blueberry	2006	0	100	100	350
Blueberry	2007	200	150	50	380
Blueberry	2011	250	150	100	400
Blueberry	2012	300	100	200	400
Blueberry	2013	300	100	200	430
Juniper	2006	0	40	40	75

Table 1 – cont.

1	2	3	4	5	6
Juniper	2007	90	50	40	70
Juniper	2011	90	50	40	100
Juniper	2012	220	160	60	160
Juniper	2013	200	120	80	150
Dog rose	2006	0	78	107	50
Dog rose	2007	166	30	136	40
Dog rose	2011	175	80	95	60
Dog rose	2012	213	98	115	50
Dog rose	2013	223	77	146	50
Boletus	2006	0	100	681	2 000
Boletus	2007	908	70	791	2 400
Boletus	2011	740	33	801	2 500
Boletus	2012	766	65	858	2 600
Boletus	2013	663	70	581	2 200
Raspberry	2006	0	600	400	300
Raspberry	2007	1 200	550	650	200
Raspberry	2011	1 100	580	520	200
Raspberry	2012	1 200	450	750	300
Raspberry	2013	1 200	500	700	320
Chanterelle	2006	0	46	238	420
Chanterelle	2007	237	28	209	470
Chanterelle	2011	247	23	224	610
Chanterelle	2012	264	25	239	500
Chanterelle	2013	280	31	249	600
Blackberry	2006	0	10	90	230
Blackberry	2007	110	15	95	200
Blackberry	2011	135	10	125	260
Blackberry	2012	160	10	150	300
Blackberry	2013	200	20	180	200
Medicinal plants	2006	0	4	161	1 500
Medicinal plants	2007	188	5	183	1 200
Medicinal plants	2011	207	2	205	1 800

Table 1 – cont.

1	2	3	4	5	6
Medicinal plants	2012	203	5	198	1 650
Medicinal plants	2013	205	4	201	1 400
Elder	2006	0	5	5	550
Elder	2007	10	5	5	480
Elder	2011	10	5	5	420
Elder	2012	10	5	5	500
Elder	2013	10	5	5	520
Wild strawberry	2006	0	3	2	320
Wild strawberry	2007	6	5	1	400
Wild strawberry	2011	7	5	2	450
Wild strawberry	2012	6	4	2	330
Wild strawberry	2013	8	4	4	400

basic panel model for example: *within, between* and *random effect models* (Chen, 2013).

Benefits of panel data analysis, compared to the others are:

- panel data contain more data than the corresponding spatial data and time series
- dependent variables are changing the units of observation and weather, and the estimates are more accurate
- panel data reduce the bias of parameters due to lack of the data
- panel data allow defining and testing the complicated econometric models
- reduce the problem of multicollinearity
- allowing to the measuring diversity within the observation units (Hsiao, 2003; Klevmarken, 1989).

Various types of panel models, depending on the model of the constraints on the parameters, are:

1. Panel model with constant regression parameters (*pooled regression*) implies the constancy of regression parameters in the model. It means that all variations of the units and over time are included by random error.

2. Model of individual effects (*fixed effects model*) means constancy of the parameters according to the regression of both dimensions. Free member can vary (only) per observation units. Such models in which the difference between the observation units is included into free variable members are called the model of individual fixed effects.

RESULTS

In order to make a cross-section of data for further analysis, the descriptive statistical analysis was conducted. The results are given in Table 2. Table 2 presents the basic characteristics of the data obtained based on descriptive statistical analysis.

Based on the existing data the annual quantity range (heterogeneity) of purchase per year is specified. From this it can be observed that there is a significant quantitative variation of redemption during the observed time interval (Fig. 1).

On the other hand, product heterogeneity (Fig. 2) was determined. Thus, it can be observed that the products with enhanced quantitative dispersions in the purchase are: blueberries, juniper, purchasing, raspberries and mushrooms. For the other products purchase is relatively uniform.

Linear regression on the data of comparative cross-sectional data or time series assumes homogeneity of the observation unit. In this particular case (Fig. 1)

Table 2. Descriptive statistics for analysed variables

Purchase	Placement	Export	Prices
Min 0.0	Min 3.0	Min 1.00	Min 40.0
1st Qu. 6.5	1st Qu. 30.0	1st Qu. 11.25	1st Qu. 200.0
Median 83.0	Median 70.0	Median 51.00	Median 400.0
Mean 210.5	Mean 123.7	Mean 140.56	Mean 629.9
3rd Qu. 209.0	3rd Qu. 142.5	3rd Qu. 115.00	3rd Qu. 542.5
Max 1080.0	Max 600.0	Max 858.00	Max 2600.0

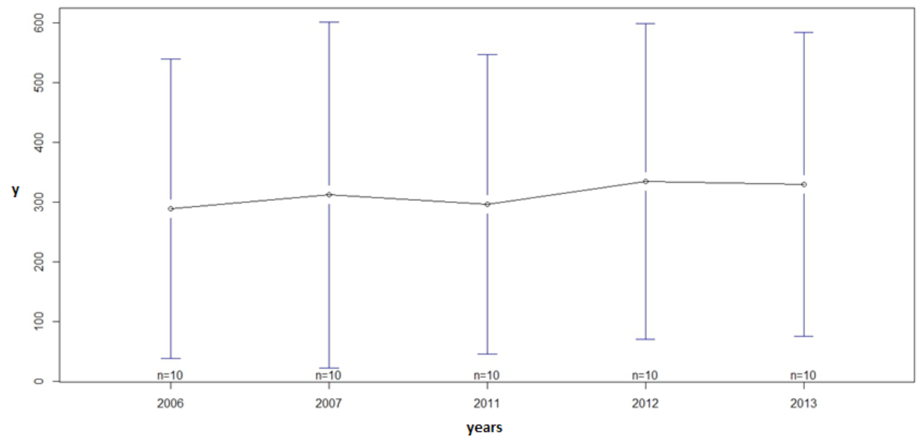

Fig. 1. Heterogeneity across years

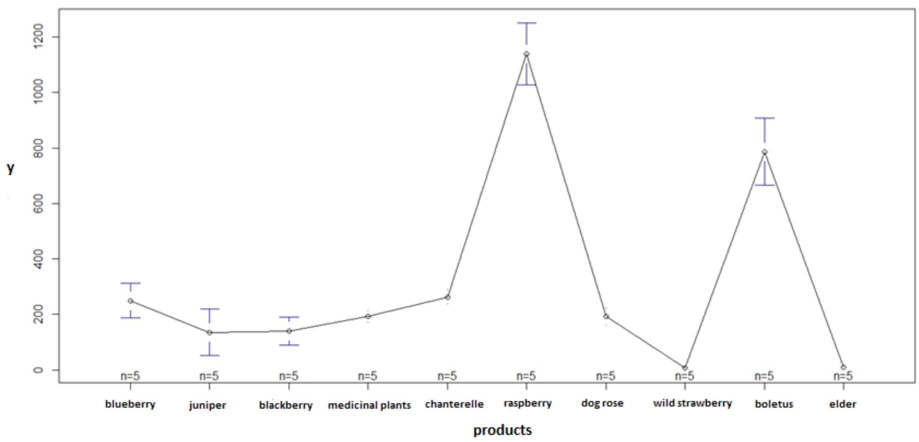

Fig. 2. Heterogeneity across products

there are significant differences in the level of purchase for different types of products.

The panel regression model parameters are not constant, which means that the impact of independent variables on the dependent ones varies according to observation units. This allows for greater consistent of estimate. By evaluating of models with constant parameters per observation units, average marks of parameters which deviate significantly from the real regression parameters are obtained.

Evaluating models with constant parameters by observation units gives average marks of parameters that deviate significantly from the real regression parameters. In this case, in the first step it is necessary to define the dependent (Y) and the independent variables (X_1, X_2, X_3):

Purchase of raw products is dependent variable, while the placement on the domestic market, exports and prices are independent variables (Table 3). In the first step is estimated pooled OLS model with all variables included. Practically, the model is estimated that does not take into account the data to be panels. In further proceedings the results were obtained as in Table 4.

Table 3. Definition of variables for analysis

Y – purchase
X_1 – placement on domestic market
X_2 – export
X_3 – prices

In relation to the others, the more significant variables were extracted: the placement on the domestic market (X_1) and export (X_2). This is indicated by the p-value that is lower than 0.001. If we compare the importance of these two variables, X_2 (export) turns out to be more significant. This is indicated by higher intercept values (Table 4). The variable “price” in this case was not significant.

However, using the panel fixed effects model (least squared dummy variable model – LSDVM) a more realistic assumption was introduced stating that prices vary depending on the product. By adding dummy variable, the variable price becomes significant, as can be seen in the further process (Table 5).

By introduction of dummy variables the influence of the prices on the quantity of purchase was separated. In this way, the most insignificant were the prices of herbs, berries and elder. Other prices (isolated) show significance in the model (Table 5).

Based on the results, it is noted that in the case of increasing placement on the domestic market by 1% increase of purchase of raw NWFPs in the coming year of 0.3% can be expected. The increase by exports of 1% can cause an increase of the quantity of purchase of NWFPs by 0.4%. While a price increase by 1% can lead to an increase in the purchase by 0.3% (Table 6). These are the sales prices of final products.

It is necessary to emphasize that these are final sale prices of products, where the stimulative increase their work at enterprises engaged in NWFPs occurs

Table 4. Linear regression (OLS)

```
Residuals
    Min      1Q  Median     3Q     Max
–122.054  –7.960   0.281   7.206  88.225

Coefficients
          Estimate std. error t value Pr(>|t|)
(Intercept) –7.626e+01  5.551e+01  –1.374    0.176
Purchase 1.040e+00  4.534e-02  22.937  <2e-16 ***
Placement on domestic market 9.606e-01  3.540e-02  27.138   <2e-16 ***
Prices –5.790e-04  1.077e-02  –0.054    0.957
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 28 on 44 degrees of freedom
Multiple R-squared: 0.9943,    Adjusted R-squared:  0.9937
F-statistic: 1538 on 5 and 44 DF, p-value: <2.2e-16
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Table 5. Panel fixed effects model

Residuals

Min	1Q	Median	3Q	Max
–140.597	–25.954	–0.269	19.943	120.205

Coefficients

	Estimate	std. error	*t* value	Pr(>|*t*|)	
x3	1.658e-02	7.325e-02	0.226	0.822085	
factor(products) blueberry	2.435e+02	3.725e+01	6.537	9.32e-08	***
factor(products) juniper	1.342e+02	2.508e+01	5.349	4.15e-06	***
factor(products) blackbery	1.371e+02	2.944e+01	4.655	3.70e-05	***
factor(products) medicinal plants	1.686e+02	1.131e+02	1.490	0.144277	
factor(products) chanterelle	2.538e+02	4.488e+01	5.655	1.56e-06	***
factor(products) raspberry	1.136e+03	3.061e+01	37.099	< 2e-16	***
factor(products)dog rose	1.916e+02	2.401e+01	7.979	1.01e-09	***
factor(products) wild strawberry	9.830e-02	3.658e+01	0.003	0.997870	
factor(products) boletus	7.480e+02	1.730e+02	4.322	0.000103	***
factor(products) elder	1.808e+00	4.327e+01	0.042	0.966890	

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 53.06 on 39 degrees of freedom
Multiple R-squared: 0.99, Adjusted R-squared: 0.9871
F-statistic: 349.3 on 11 and 39 DF, *p*-value: <2.2e-16

Table 6. Final panel fixed effects model

Residuals

Min	1Q	Median	3Q	Max
–0.127974	–0.051444	–0.004814	0.045793	0.176583

Coefficients

	Estimate	std. error	*t* value	Pr(>|*t*|)	
ln_placement on domestic market	0.30851	0.04020	7.675	3.64e-09	***
ln_export	0.43918	0.04768	9.212	4.10e-11	***
ln_prices	0.30509	0.07646	3.990	0.0003	***
factor (products) blueberry	0.12986	0.45396	0.286	0.7764	
factor (products) juniper	0.36009	0.36302	0.992	0.3277	
factor (products) blackberry	0.35737	0.41147	0.869	0.3907	
factor (products) medicinal plants	0.31769	0.53808	0.590	0.5585	
factor (products) chanterelle	0.22582	0.47067	0.480	0.6342	
factor (products) raspberry	0.60308	0.47804	1.262	0.2150	
factor (products) dog rose	0.66561	0.34044	1.955	0.0582	.
factor (products) wild strawberry	–0.70918	0.43747	–1.621	0.1135	
factor (products) boletus	0.11577	0.58141	0.199	0.8433	
factor (products) elder	–0.79188	0.44960	–1.761	0.0865	.

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.08478 on 37 degrees of freedom
Multiple R-squared: 0.9998, Adjusted R-squared: 0.9997
F-statistic: 1.428e+04 on 13 and 37 DF, *p*-value: <2.2e-16

to increase the purchase in order to make a sale at higher market prices.

Hausman test was used for the choice between fixed model and a random effects model (Table 7). On the basis of the calculated value it can be concluded that in this case, we should choose a fixed effects model. This is indicated by p-value (lower than 0.05) which is the condition, according to Hausman test, to accept the fixed effects model as appropriate (Table 7).

Table 7. Hausman test

data: $y \sim x_1 + x_2 + x_3 + x_4 + x_5$
chisq = 4.7444, *df* = 1, *p*-value = 0.02939
alternative hypothesis: one model is inconsistent

The same was confirmed by using Akaike's information criterion (AIC). When choosing between alternative models it is necessary to choose the one with the lower values of AICs. In this case it is a fixed effects model with a value of AIC of –91.9 (Table 8).

Table 8. AIC

AIC (ols, *k* = 2)
[1] 482.7251
AIC (fixed.dumF2, *k* = 2)
[1] –91.93219

CONCLUSION

Analysing the analyzed data, it was found that there was a significant heterogeneity in terms of both products and years. This shows a balance of the purchase, both within each category of products, as well as the year.

Increase of placement on the domestic and foreign markets indicates a growing demand for this type of products. These market conditions have a stimulating effect on enterprises to buy more raw products in order to satisfy the growing demand for final products. Hence, the aim is to achieve a positive operating result, primarily by focusing the product portfolio on the market attractive products.

Next, fixed-effect models were evaluated. In this way, the hypothesis that observation units have a common intersection with the y-axis (intercept) was rejected. Thereby variable "price" becomes significant.

The introduction of dummy variables and the effect of price allocation identified the products which price shows a strong impact on the volume of purchase of raw materials. By separation of price effects, products which prices had strong influence on the quantity of purchase of raw material were identified.

These are: blueberry, blackberry, chanterelle, raspberry, rose hip, cranberry and boletus.

On the other hand, products whose prices had no impact on the volume of purchase of raw products are: juniper, elderberry and medicinal herbs.

The future research will focus on the introduction of many variables having any influence on the market of NWFPs in Serbia. Besides, the time series will be extended. Consequently, it will be determined how to increase the number of observations affecting the relationship between the variables that are the subject of the analysis.

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USE OF PANEL DATA IN FUNCTION OF MARKET RESEARCH OF NON-WOOD FOREST PRODUCTS IN SERBIA

ABSTRACT

The research was aimed at identifying the impacts of selected variables (quantity of placed products on the domestic market, quantity of export and prices of final products) on the purchase of raw materials. The statistical significant impact of placement on the domestic market and export was identified. According to the research, prices of final products had not stimulative effect on the enterprises to increase the amount of purchased raw materials. However, by the introduction of dummy variables the impact of prices of certain product categories was identified that had no impact on the purchase of raw materials. Those are: herbs, juniper and elderberry. Other prices (isolatated) show significance in the model. In addition it was found that there was no significant heterogeneity in terms of products as well as ages. This indicates a balance in the purchase, both within each category of products, as well as on the overall level of the year. Increasing placement oin the domestic market of NWFPs by 1% can be expected to increase the purchase in the next year by 0.3%. On the other hand an increase of exports by 1% can be achieved by an increase in the purchase of raw materials by 0.4%. If there is an increase in the price of final products by 1%, it can be expected to increase the purchase in the next year by 0.3%.

Keywords: panel data, Central Serbia, enterprises, non-wood forest products