Ukrainian Catholic University

Faculty of Applied Sciences

Business Analytics & Computer Science Programmes

Ukrainian Pets Market

Econometrics first interim report

Authors:
Iryna Voitsitska
Yaryna Petruniv

18 March 2024

Contents

Abstract

This project investigates the impact of the full-scale invasion of Ukraine by Russia in 2022 on the Ukrainian internal and foreign markets for pet products. The main objectives are to determine whether significant changes occurred in the turnover of pet goods in Ukraine and if there was a decrease in export volume following the onset of war. The analysis employs econometric methods, suitable for panel data analysis.

Keywords: Econometric Analysis, Pet Industry, Pet Market Analysis

1 Introduction

The topic of this project is the research of Ukrainian Pets Market between 2021 and 2023. The aim of this project is to explore and analyze Ukrainian internal and foreign markets for pets products. Determine whether it has changed drastically with the beginning of full-scale invasion of Ukraine launched by russia in 2022. This area is unique and interesting because there are no fundamental studies relating to pets products. Ukrainian companies that distribute such vendibles are the audience of this project, especially Suziria Distribution, which is a Ukrainian company that have been significantly influencing the market for the last 30 years. This is also the company that provided the data for this project. The main questions that are expected to be covered are the following:

- Was there a significant change in Ukrainian market for pets goods turnover?
- Did the export volume of goods for pets decrease with the beginning of full-scale war?

During the further research there might arise more questions that can be considered.

2 Literature Review

For discovering methods that are going to be used in this project the following literature is going to be researched:

- "Mostly Harmless Econometrics" by Joshua D. Angrist - It shows the basic tools of applied econometrics such as linear regression for statistical control, instrumental variables methods for the analysis of natural experiments, etc.
- "Econometric Analysis of Cross Section and Panel Data" by Jeffrey M. Wooldridge — The second edition of this textbook provides a comprehensive treatment of econometric research, covering both cross-sectional and panel data methods. The book offers a thorough framework for econometric analysis, including broader coverage of missing data and cluster problems, as well as new discussions on treatment effects with panel data;
- Video series *"A full course in econometrics - undergraduate level"* [1] by Ben Lambert - This selection of videos covers a full course in econometrics. It starts at the absolute beginning assuming no prior knowledge, and will eventually build up to more advanced topics in regression analysis;

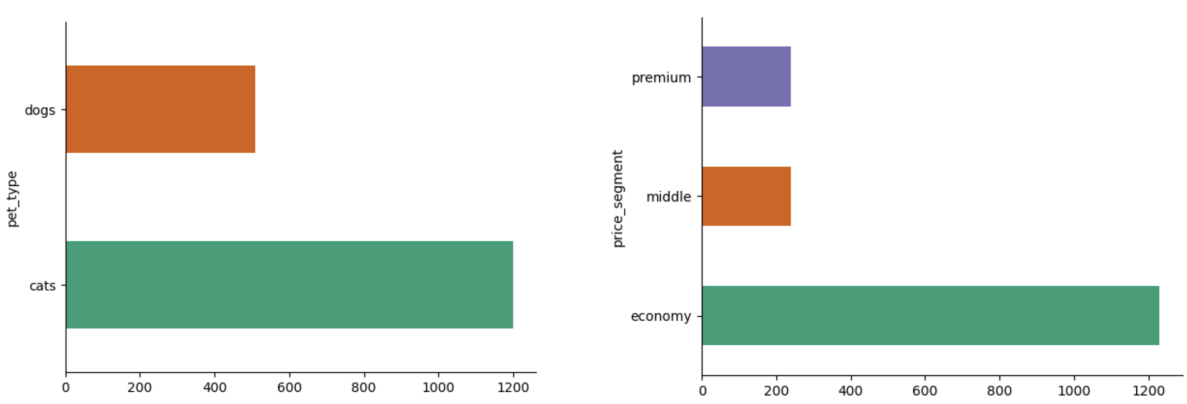
- *Analysis of the Future Development Trend of the Pet Industry* [2] — This article addresses challenges through a analysis spanning political, economic, social, and technological fields. The findings indicate a projected upward trajectory for the market economy of the pet industry;
- *"Europe Pet Food Market Size and Share Analysis"*[3] — The report includes the pet market volume, the market size of pet food by products, distribution channels, etc.

3 Data analysis

Suziria Distribution provided the datasets for this project. There are four large datasets that include various data on Ukrainian internal and export market for pets products, such as revenue and number of items/kilograms sold by a company during determined periods of time. The datasets one can find by the following ***link***. For answering the question about the impact of the war on export volume the data was cleaned and the ***new dataset*** was constructed. The data for this project contains the following columns:

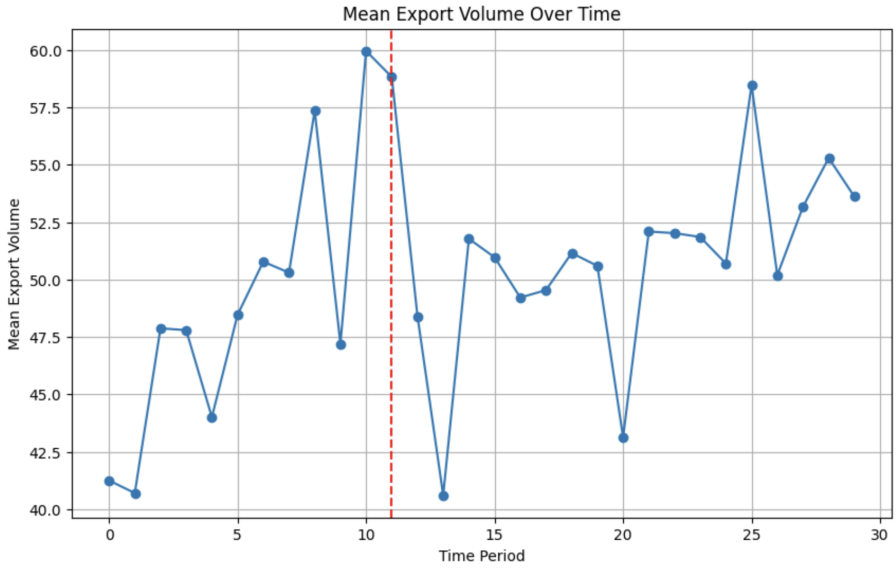
- *export_volume_units*: the volume of pet food exports measured in units.
- *export_volume_tons*: the volume of pet food exports measured in tons.
- *price*: the price of pet food exports measured in millions of hryvnias.
- *price_per_unit*: the price of pet food exports per one unit.
- *war*: a binary variable indicating whether there was a war (1) or not (0) during the export period.
- *category*: the category of pet food product. The categories are *wet*, *dry_cats_and_dogs*, *treats*. Before building the model, the categories will be converted into the dummy variables.
- $manufacturer$: name of the company that is responsible for manufacturing the pet food products.
- *pet_type*: the type of pet for which the food is intended. The types are *cats*, *dogs*. Before building the model, the types will be converted into the dummy variables.
- *price_segment*: the price segment of the pet food product (*economy*, *middle*, *premium*). Before building the model, the segments will be converted into the dummy variables.
- *package_type*: the type of packaging used for the pet food products (*can*, *pack*, *pouch*, *sack*). Before building the model, the types will be converted into the dummy variables.
- *export*: A binary variable indicating whether the product was exported (1) or not (0).
- *observation*: a categorical variable indicating different observations.
- *time_period*: the time period during which the export occurred. There is available data for each month from January 2021 to June 2023.

Let's take a closer look at the data.

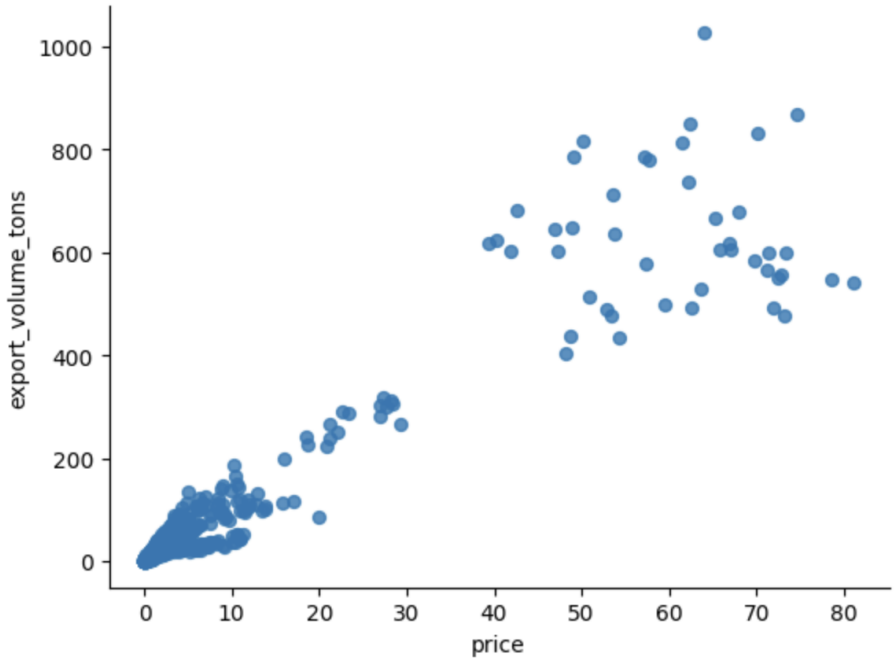


On the given plots, one can see that the cat food is the most popular for the export, considering price segment, economy one is the mostly exported.

The hypothesis that are going to be tested is whether the export volume of goods for pets decrease with the beginning of full-scale war.



On this plot, the x-axis shows the months labeled from 1 to 30 where the 13 month is February 2022 and y-axis shows the mean value of export volume in tons within this time period. Looking at the plot, one can observe that there was a significant decrease in export volume in December 2022 (two months before the full-scale invasion) and then relatively quickly the price has stabilized.



On this plot, one can observe that the price is highly correlated with the export volume, which is actually pretty expected. The same observation are going to be seen while analyzing the results of fixed affects model.

4 Methodology

The main methods that are going to be used in the research are the ones that are most commonly used to analyse penal data, such as Fixed Effects Models and Random Effects Models.

For testing the hypothesis about decrease in export volume due to the start of full invasion the **fixed effects model** and **random effects model** are used. A new dummy variable *war* are created to divide the data into two periods. Now the following model is created:

$$y_{it} = \beta_0 + \delta_0 war + \beta_1 x_{it} + a_i + u_{it}$$

For the following project, in the notation y_{it}, i denotes the particular brand of the pet goods and t denotes the time period. The variable a_i captures all time-constant factors that affect y_{it}. a_i is called an unobserved effect. u_{it} is often called idiosyncratic error or time-varying error, because it represents unobserved factors that change over time and affect y_{it}. Fixed effects removes the effect of time-invariant characteristics so one can assess the effect of the predictors that are dependent on time on the outcome variable.

In the random-effects model the assumption is that the effect varies from one observation to the next one, and that the observation are randomly sampled from the population. Also, it assumes that the true effect could vary from observation to observation because of heterogeneity. Thus, in such analysis time-invariant variables can be added to the model. For example, the effect of russian invasion can be different based on category of observation or manufacturer, as distinct manufacturers could handle the difficulties caused by the war differently.

In this project, two models are to be implemented. Then, the authors plan to determine which one is the better fit for the data. In the data there are 20 entities with

complete data that correspond to Ukrainian export. To implement Fixed Effects Model and Random Effects Model plm model in R was used.

To determine which method among Fixed Effect Model and Random Effects model is better, the authors used Hausman test. The null hypothesis is that the individual effects are not correlated with the x_{it}. If the p-value is significant then fixed effects would be used, if not random effects would be used. Hausman test statistics is calculated the following way:

$$H = \frac{\beta_0 - \beta_1}{Var(\beta_0) - Var(\beta_1)}$$

The following hypotheses are constructed:

- H_0: The appropriate model is *Random effects*. There is no correlation between the error term and the independent variables in the panel data model.
- H_1: The appropriate model is *Fixed effects*. The correlation between the error term and the independent variables in the panel data model is statistically significant.

5 Results

The Fixed Effect Model was constructed:

$$log(export\_volume\_units) = \beta_0 + \beta_1 war + \beta_2 price + a_i + u_{it}$$

The following results are obtained:

```
Coefficients:
       Estimate Std. Error t-value  Pr(>|t|)
war   -0.182369   0.063007 -2.8944  0.003942 **
price  0.255350   0.024162 10.5683 < 2.2e-16 ***
```

We get the p-value of 0.0039 while testing the hypotheses:

1. $H_0 : \beta_4 = 0$
2. $H_1 : \beta_4 \neq 0$

Under the null hypothesis we assume that, once all of the other independent variables have been accounted for, war has no impact on the export volume.

To test this hypotheses *t-statistics* is used:

$$t = \frac{\hat{\beta}_1}{SE(\hat{\beta}_1)}$$

- $\hat{\beta}_1$ is the estimated coefficient for the war variable.
- $SE(\hat{\beta}_1)$ is the standard error of the coefficient estimate.

t-statistic measures the number of standard deviations that the estimate $\hat{\beta}_1$ is away from zero. Intuitively, if the absolute value of the t-statistic is large, it indicates that the coefficient estimate $\hat{\beta}_1$ is far from zero relative to its standard error.

The $t-statistic$ is smaller than $t_{0.025}$ and p-value is small enough, so the null hypothesis would be rejected and one can say that the war has an impact on the export volume.

The estimated coefficient near the war variable is -0.182 which means that the war has decreased the export volume by approximately 18% on average.

The *Random Effect Model* was constructed in the same way but it also takes into account the variables that are constant over time. The following results are obtained:

```
                                Estimate Std. Error z-value  Pr(>|z|)
(Intercept)                    7.0309115  0.7064366  9.9526 < 2.2e-16 ***
war                           -0.1763630  0.0672160 -2.6238  0.008695 **
price                          0.2382246  0.0602000  3.9572 7.583e-05 ***
export_volume_tons             0.0012536  0.0029561  0.4241  0.671502
category_dry_cats_and_dogsTrue 0.1593171  0.6199424  0.2570  0.797189
category_treatsTrue            0.1192782  0.8583505  0.1390  0.889480
pet_type_catsTrue              1.1383109  0.4562124  2.4951  0.012591 *
price_segment_economyTrue      0.3643420  0.5667240  0.6429  0.520294
price_segment_middleTrue       0.6306134  0.5864345  1.0753  0.282225
package_type_pouchTrue         2.9157245  0.6184863  4.7143 2.426e-06 ***
```

The p-value of the t-test corresponding to war variable is 0.008695 which is also small enough to reject the null hypothesis. The interpretation is pretty the same: the war has decreased the export volume by approximately 17.6% on average.

Let's conduct Hausman test to choose between two models. The p-value of 0.8104 was obtained, so the null hypothesis wouldn't be rejected. So the appropriate model for the project data is *Random Effects Model*.

6 Conclusions

On this stage of the project, the hypothesis about the dependence between the start of full-invasion and export volume was tested. And indeed it was shown that the war has dependent on the export volume of Ukraine. It has decreased the export volume by approximately 17.6%. To the final report the authors will also investigate the Ukrainian internal market for pets goods and how the war has affected it.

7 Plan for Future Research

At this point, the plan for future research is to conclude on the optimal approach and successfully implement the algorithm. Other long-term goals are improving the algorithm for better accuracy and efficiency and investigating the algorithm's applicability to other domains.

1. **By the 25th of March**: clean-up the data, find additional useful information for the research, construct hypotheses;
2. **By the 4th of April**: test basic hypotheses, decide on further questions to be investigated and approaches to be used;
3. **By the 14rd of April**: investigate additional questions and improve existing results;
4. **By the 18rd of April**: add finishing touches and formulate conclusions;
5. **By the 19th of April**: make the presentation with final results.

The possible challenging part of the project is understanding the math behind the algorithms. Also, problems like data quality and bad accuracy can occur.

References

[1] A full course in econometrics-undergraduate level. Retrieved from: https://www.youtube.com/playlist?list=PLwJRxp3blEvb7P-7po9AxuBwquPv75LjU.

[2] Analysis of the Future Development Trend of the Pet Industry. Retrived from: https://drive.google.com/drive/folders/1lfJLwo6ml1bSzpN6nwQGrId2EK1QCzQL?usp=share$_link$.

[3] Europe Pet Food Market Size and Share Analysis. Retrived from: https://www.mordorintelligence.com/industry-reports/pet-food-market-in-europe-industry.