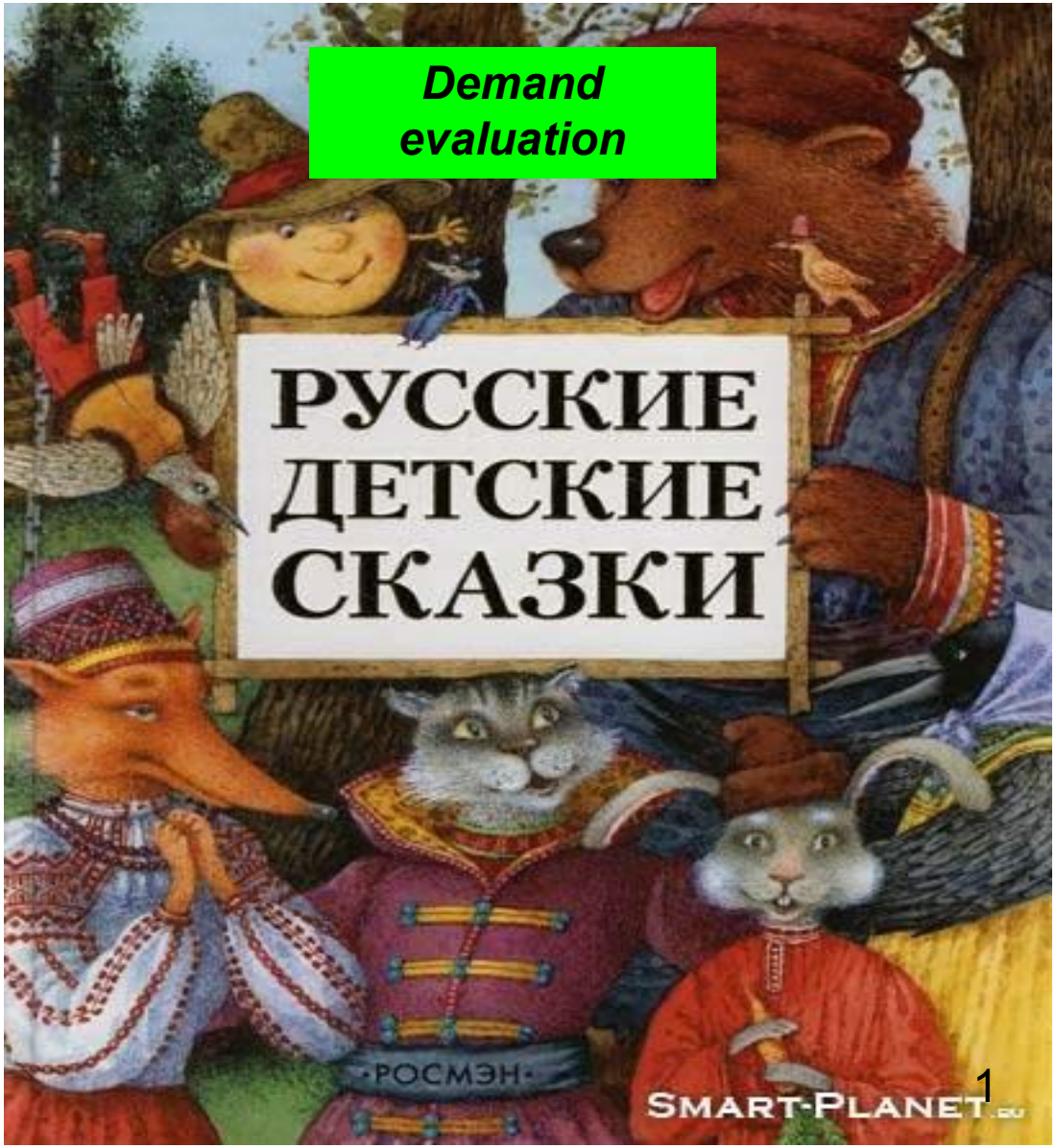
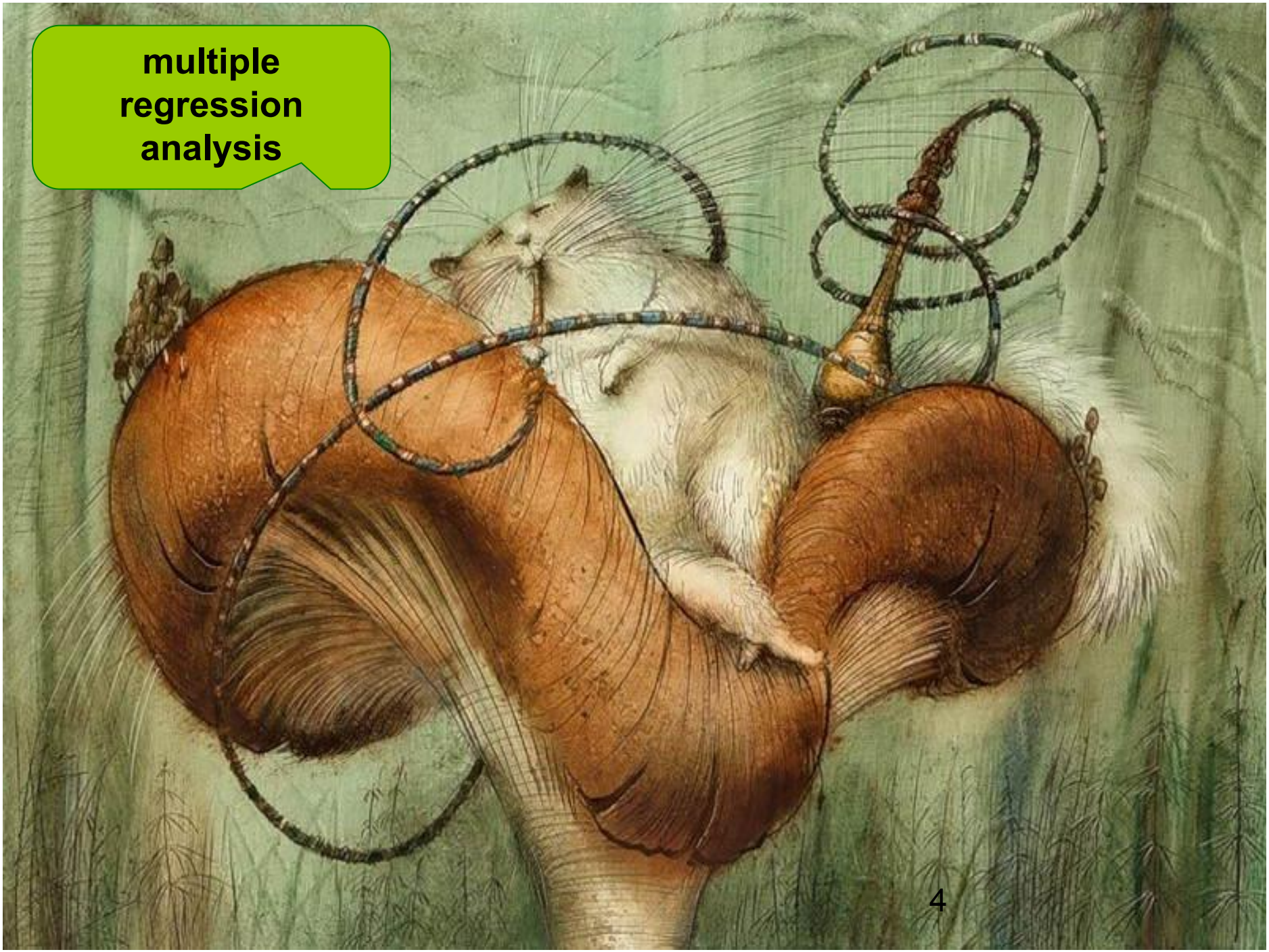
Multiple regression analysis



Simple linear regression is used to analyze the relationship between one independent variable affecting the demand, and the required quantity of goods or services

In some cases, changes in demand are satisfactorily explained by changes of one independent variable, such as price

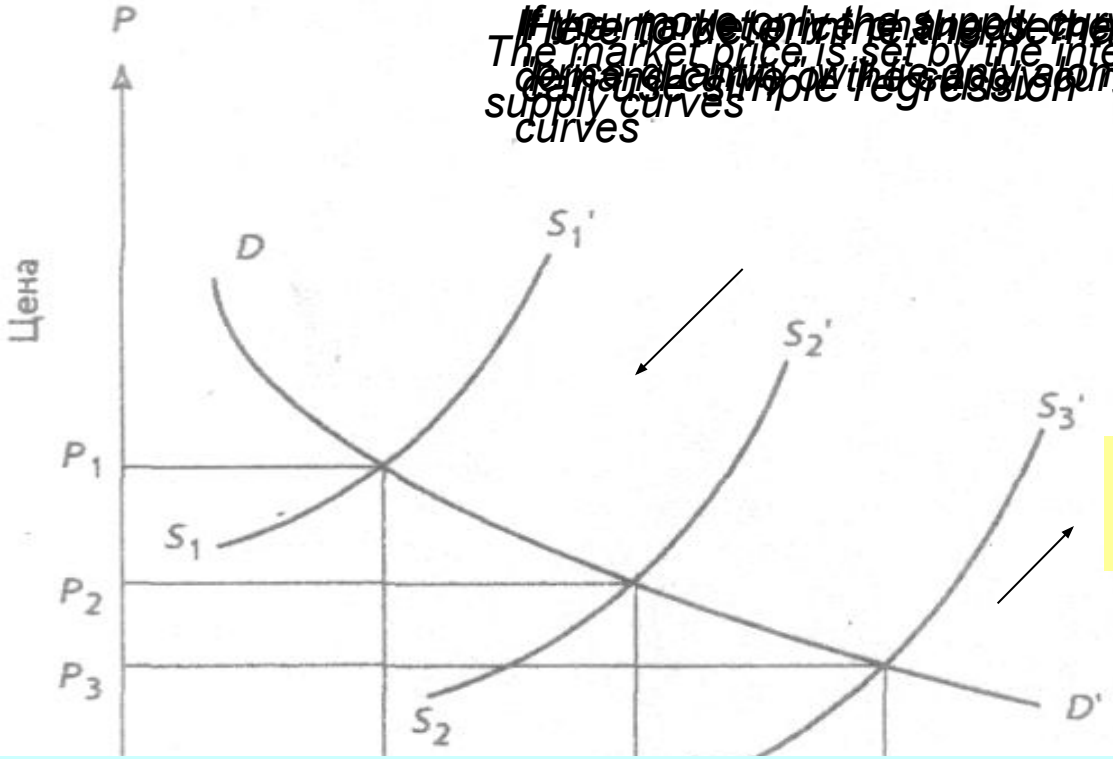
We would like to investigate the relationship between demand and more than one independent variable that can be changed


multiple
regression
analysis

When using simple pair regression we consider that demand changes as a result of price changes, while other variables are constant

$$Q_d = f(P \mid T, I, P_r, E, R, N, A, O)$$

The market price is set by the intersection of demand and supply curves



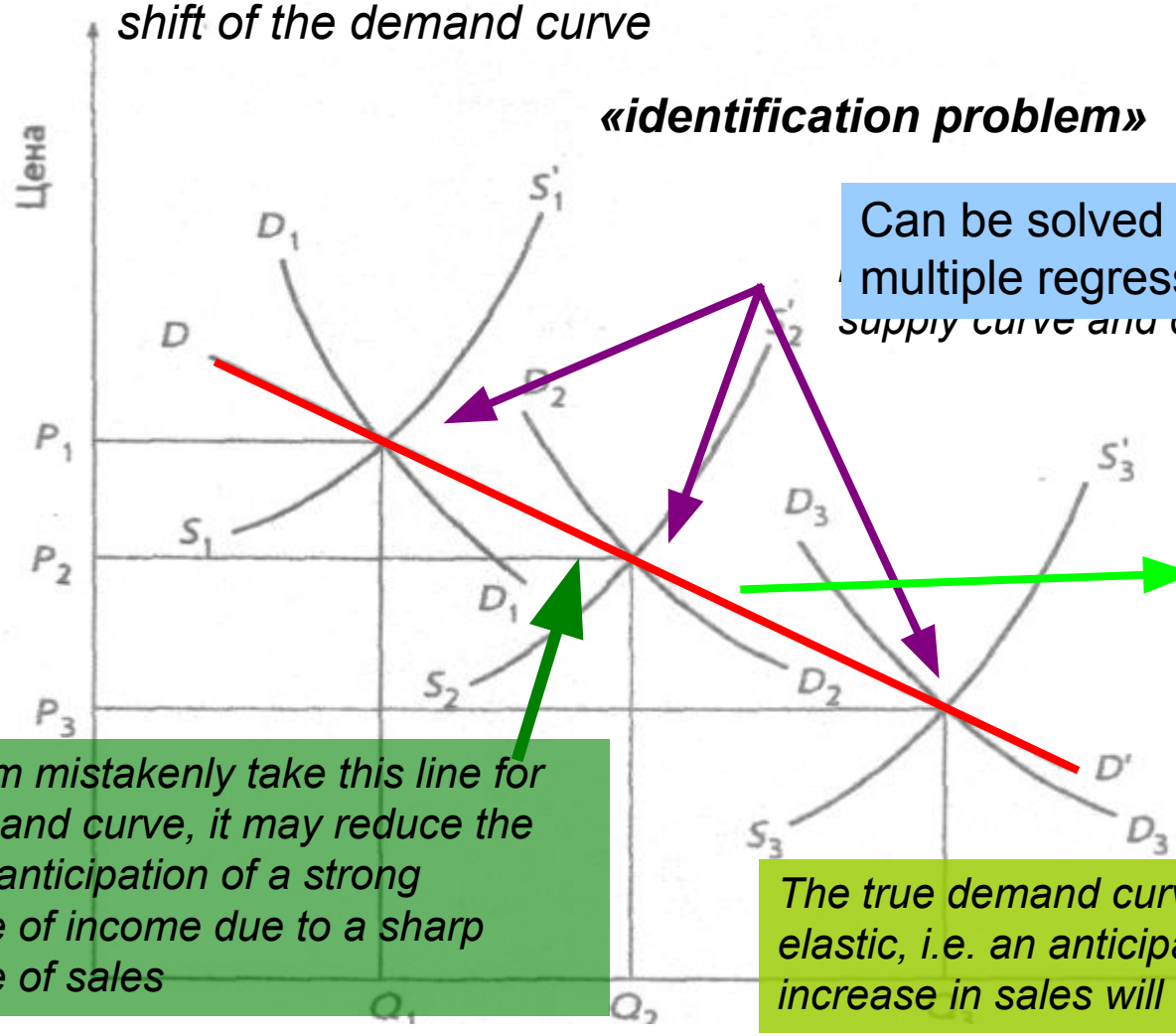
Ex: the market of microprocessors

Technological progress is rapidly reduced production costs of these devices, so the producers had a desire to expand production: the supply curve shifted to the right

Any change in any other variable, except price will cause a shift of the demand curve

«identification problem»

Can be solved by using multiple regression



The demand function of one variable?

If the firm mistakenly take this line for the demand curve, it may reduce the price in anticipation of a strong increase of income due to a sharp increase of sales

The true demand curve is less elastic, i.e. an anticipated increase in sales will not occur

Construction of multivariable demand function

Task: Reflection of the relationship between dependent and independent variables

Construction of multivariable demand function

Step 1. Identification of variables

Demand is a function of many variables. In empirical studies it is necessary to identify the independent variables and their relationship with the dependent variable.

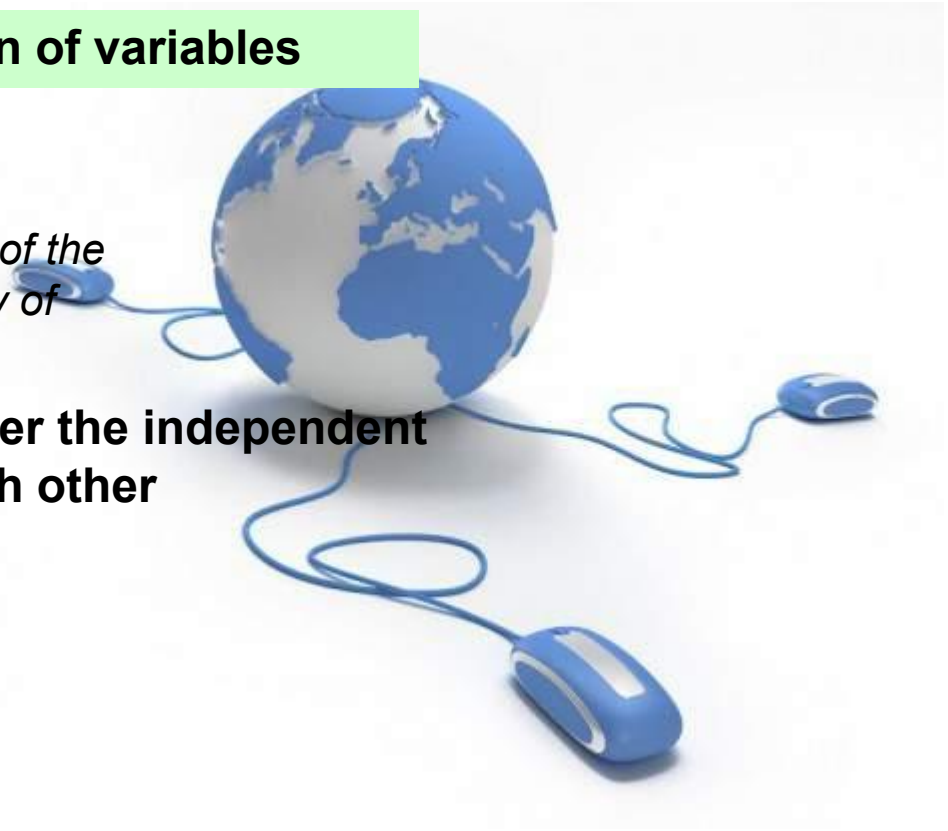
The demand model may have the following form:

$$Q_d = f(P, T, I, P_r, E, R, N, A, O)$$

- Q_d — *The quantity of product demanded*
- P — *Price*
- T — *Tastes of consumers*
- I — *Consumer's Income level*
- P_r — *Prices of substitutes*
- E — *Consumer's expectations*
- R — *Available Volume of product*
- N — *Number of potential consumers*
- A — *Advertising*
- O — *Another factors*

Construction of multivariable demand function

Step 1. Identification of variables



It is not enough to determine the relationship of the demand variables with the necessary quantity of goods

We must also determine whether the independent variables are connected to each other

Step 2. Collection and refinement of data

Consider the following aspects:

- **Organization of information (month, quarter, year);**
- **The number of observations required to obtain good results**

Construction of multivariable demand function

Step 2. Collection and refinement of data

1) **Organization of information (month, quarter, year);**

availability!

A greater number of observations allows us to achieve greater statistical efficiency

- ✔ **Correction: taking into account population and inflation;**
- ✔ **seasonal adjustment (for quarterly data);**
- ✔ **the reaction of economic phenomena to changing conditions with some delay**

Step 2. Collection and refinement of data

2) The number of observations required to obtain good results

Basic rule: well-chosen model requires the number of observations, that is at least three or four times more than the number of independent variables

Construction of multivariable demand function

Step 3. Choosing the best form of equation

If the trend of the experimental values of the dependent variable is approximately linear, and there are many independent variables, the estimated equation is:

Constant value

Estimated value of the i-th regression parameter

$$\hat{Q} = b_0 + b_1 X_1 + b_2 X_2 + \ldots + b_X X_X$$

The estimated demand

The value of independent variable

Construction of multivariable demand function

Step 4. The determination of the regression equation

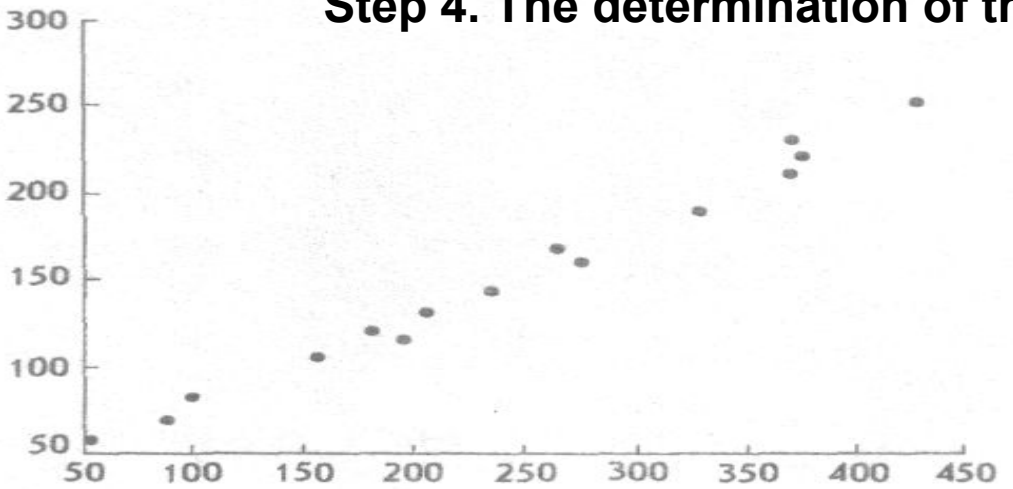
Import of mushrooms data

City	*Sales per week (boxes)*	*Quantity of potential consumers (thousands)*	*Income per capita*
	Q	X_1	X_2
1	162	274	$2450
2	120	180	3254
3	223	375	3802
4	131	205	2838
5	67	86	2347
6	169	265	3782
7	81	98	3008
8	192	330	2450
9	116	195	2137
10	55	53	2560
11	252	430	4020
12	232	372	4427
13	144	236	2660
14	103	157	2088
15	212	370	2605

Construction of multivariable demand function

Step 4. The determination of the regression equation

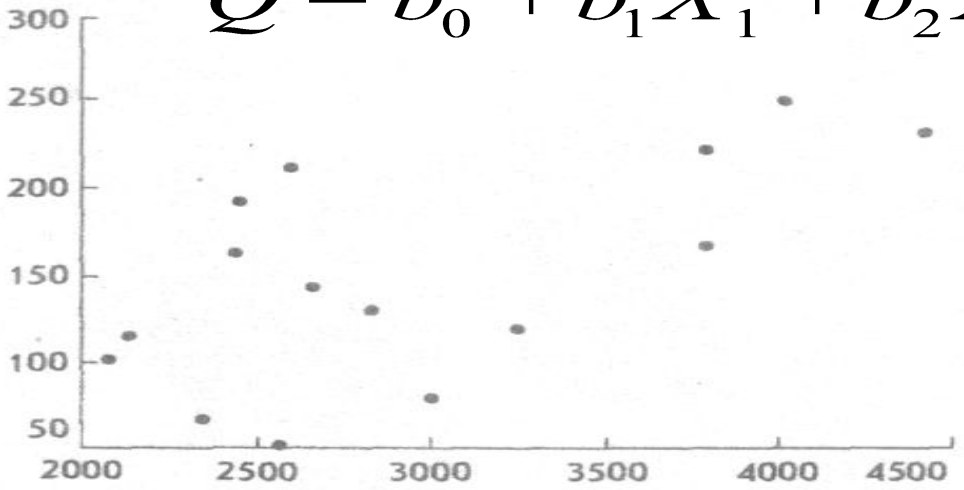
Sales per week (boxes)



Quantity of potential consumers (thousands)

$$\hat{Q} = b_0 + b_1 X_1 + b_2 X_2$$

Sales per week (boxes)



Income per capita

Construction of multivariable demand function

Step 4. The determination of the regression equation

$$Q = 3{,}5 + 0{,}5\,X_1 + 0{,}009\,X_2$$

Variable №	B	Root-mean-square error of regression coef.	Соотношение для t-тестирования
0	3,45301	2,43013	1,42091
1	0,496006	6,05316E-03	81,9416
2	0,009	9,67909E-04	9,60389

Dispersion analysis	Sum of squares	Средний квадрат	F-критерий (Фишера)
Регрессия	53844,7	26922,4	5681,88
Ошибка	56,8694	4,73828	
Итого	53901,6		

Число степеней свободы для регрессии – 12

coefficient of determination $R^2 = 0.998945$ $R = 0,999472$

Root-mean-square error of regression = 2,17676

Показатель Дурбина–Ватсона = 2,70218

Construction of multivariable demand function

The task of the researcher is to determine the correctness of application of the results for demand forecasting

Testing and evaluation of results

Testing the suitability of the model

The suitability of the model can be determined by answering two fundamental questions:

1) **Whether the regression parameters of the correct sign and a reasonable value?**
2) **How well changes in demand are explained by changes in the independent variables?**

The answer is based on economic theory and on the judgment of the researcher

There should be some statistical tests conducted that evaluate the individual parameters and the model in general