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## RESEARCH OF CONSUMER DEMAND USING SIMULATION METHODS

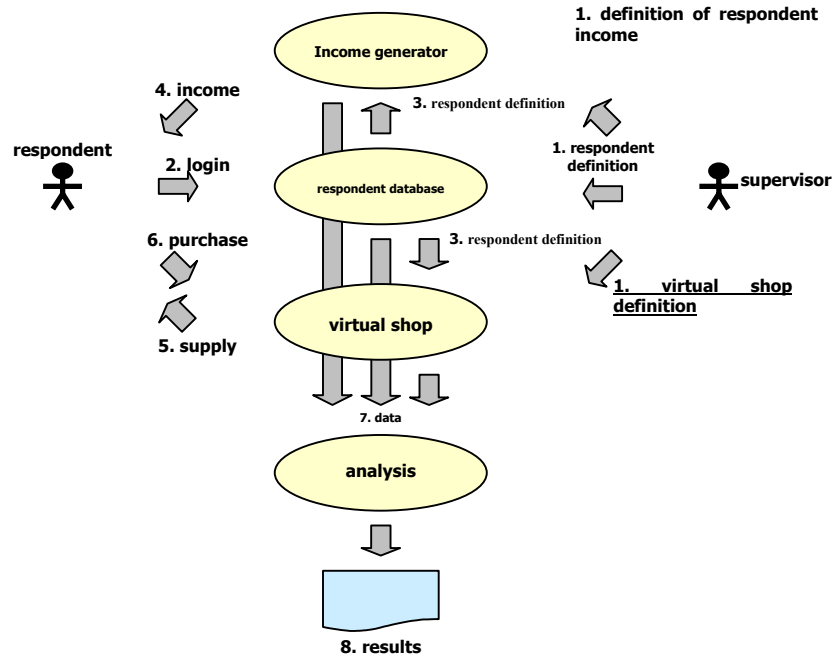
### 1. INTRODUCTION

The idea of research of consumer demand using computer simulation is probably very old. We started to work on in approximately five years ago. We applied for extra funding so we worked on the project in frame of to projects:

- Project called “Research of basic characteristics of microeconomic environment in the Czech Republic using nontraditional methods of computer simulation” (GAČR 402/00/0499)
- Institutional research called “Research of strategic management in Czech companies” (CEZ:J 22/98 265 100018)

In frame of those two projects we created model of simulation and we programmed an environment or a tool suitable for further research and development. The environment is accessible via Internet on the address [merlin.fbm.vutbr.cz/grant](http://merlin.fbm.vutbr.cz/grant) (The web page might be temporarily down because of changes of program or might be change due to reorganization of IS/IT system at university. For actual address contact author on [dvorakji@fbm.vutbr.cz](mailto:dvorakji@fbm.vutbr.cz)), but it is only in Czech and is protected by login and password.

The model we created is shown on the following picture (Model simulation).  
Picture 1. Model of simulation



The simulator may run several independent projects. Each project can simulate different situation on a market. There might be defined users, families, social groups, products or services, changes of income or prices, or even time compression.

## 2. EXPERIMENT

The experiment I tried was set up for my students. More than two hundred students actively participated.

I defined for them 352 items in 7 categories: food and beverage, household, transport, telecommunication (payments to mobile phone operators), newspapers, telecommunication equipment (mobile phones). I chose these categories, because others might be difficult to describe verbally or I am not an expert in that area. The prices of every item were set as it is on Czech market. I randomly chose 50% of all goods and every period I changed the price of half of them by 10% up and the second half 10% down.

The experiment lasted 5 periods (one period equaled one month, but time was compressed, so it took just couple of hours to complete the whole experiment).

For the first time I gave each student 3.000 CZK (about 100 Euros) per period. It is rather low amount of money for a student to keep alive in Brno. Normally students need about 4.000 CZK to live. One has to be very modest to survive with just 3.000 CZK.

When students completed all five periods, they had to complete it once again, but they had 10.000 CZK per period. Such amount of money they usually do not have available. By changing their income and everything else keeping same I wanted to know how people react on changes of income.

I received a vast amount of data to analyze. The students bought 50 000 different items and spend couple of millions CZK. I had to reduce this amount of data and find some relevant dependencies. I reduced the number of items that were examined to 54. The reason for elimination of an item might be:

- no change in price (because I changed prices only of 50% of items it eliminated immediately one half of the items),
- to few items purchased in a period (I did not want to calculate with items that were not statistically important, for example if there was just one piece of an item bought in a period and then in the second period two, it would be increase of 100%, which may influence results in a wrong way),
- to huge variety of numbers of purchased items (if there was an item, which was normally 100 pieces bought in a period and there was a period in which there was 1000 of pieces bought, it looked suspicious and the item was eliminated)

## 3. RESULTS

I looked on the data I had received from different angles and here are presented some results. But first let me ask some questions:

- Which category(s) (food and beverage, household, transport, telecommunication, newspapers, telecommunication equipment) tends to be less dependent on changes of income and which tends to be more?
- Can be found some changes in expenditures between the first and the last period (even those there was no seasonal influence)?
- Are the results of the research reliable?

No let me introduce the answers of those questions:

- Which category(s) tends to be less dependent on changes of income and which tends to be more? There was no surprise taking place in this case. The following tables show the average expenditures per each category. The first table shows the situation when the students had lack of resources. The second shows the situation with resources set too high. We can see that during the scarcity there is a tendency to spend money on basic items like food, transport, households. On the other hand when the resources are high students tends to spend money on luxury products and services as mobile phones.

Table 1

Average expenditures per category

| Categories            | Average exp. |
|-----------------------|--------------|
| Food                  | 1 036 CZK    |
| Transport             | 503 CZK      |
| Household             | 432 CZK      |
| Telecommunication eq. | 333 CZK      |
| Beverages             | 291 CZK      |
| Telecommunications    | 231 CZK      |
| Newspapers            | 67 CZK       |

| Categories            | Average exp. |
|-----------------------|--------------|
| Telecommunication eq. | 3 197 CZK    |
| Food                  | 1 972 CZK    |
| Transport             | 791 CZK      |
| Household             | 725 CZK      |
| Beverages             | 573 CZK      |
| Telecommunications    | 467 CZK      |
| Newspapers            | 146 CZK      |

- Can be found some changes in expenditures between the first and the last period. Even it seems to be very strange; there were very strong differences between expenditures in each period as it is shown in the following table. Generally speaking we can see that students had tendency to save money till the last period. Then they realized that they saved too much and spent more. The lesson I have learned from this is that it is not good if students know exact number of periods, then they behave differently (it is like someone is aware of the day he or she dies). The second I have learned is that when there are too many periods, students are not able to keep attention (we can see it in the 4<sup>th</sup> period respectively the 3<sup>rd</sup> period).

Table 2

## Dynamics of expenditures

| Period | Average exp. | Average exp.<br>with lower income |
|--------|--------------|-----------------------------------|
| 1      | 6 135 CZK    | 2 734 CZK                         |
| 2      | 6 897 CZK    | 2 598 CZK                         |
| 3      | 8 034 CZK    | 2 366 CZK                         |
| 4      | 7 322 CZK    | 2 774 CZK                         |
| 5      | 10 985 CZK   | 4 015 CZK                         |

- Are the results of the research reliable? The level of reliability is very difficult to determine. It is better to speak about ideas and future ways of research, because during the research we found also many problems and “blind alleys”. For example it was very difficult to present items to students, as well there might be doubt that students had not behaved in way they would have behaved in case of real life.

And finally let me present some parameters we found. Gathered data was approximated by  $P=Ae^{BQ}$  and than elasticity of demand was calculated as it is shown in the following table.

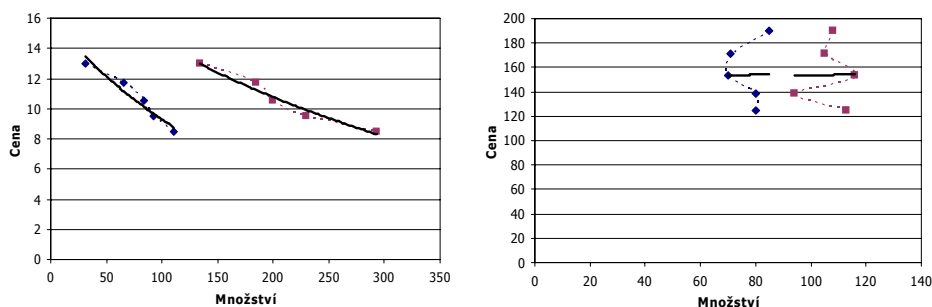
Table 3

Demand curves of selected item and their elasticity of demand ( $E_D$ )

| Item          | Income = 3 000 CZK |          |          | Income = 10 000 CZK |          |          |
|---------------|--------------------|----------|----------|---------------------|----------|----------|
|               | A                  | B        | $E_D$    | $E_D$               | A        | B        |
| Bacon 100g    | 15,87369           | -0,00537 | -2,58705 | -1,78781            | 18,82578 | -0,00279 |
| Apetito       | 35,58228           | -0,00560 | -2,04141 | -2,32421            | 32,53255 | -0,00179 |
| Car           | 5,79253            | -0,00019 | -2,80914 | -2,24214            | 6,58704  | -0,00004 |
| Bus           | 1,02355            | -0,00002 | -2,02007 | 4,86667             | 0,50064  | 0,00001  |
| Cake          | 32,91247           | 0,00194  | 9,85045  | 1,54254             | 18,83204 | 0,00407  |
| Potatoes 100g | 3,46355            | -0,00079 | -1,53245 | -2,33806            | 2,77225  | -0,00029 |
| Broccoli      | 30,69385           | -0,01388 | -3,31418 | -1,01622            | 59,99090 | -0,01643 |
| Bred          | 36,56653           | -0,00330 | -1,11566 | -2,32955            | 22,46444 | -0,00097 |
| Onion 100g    | 1,39722            | -0,00092 | -4,88877 | 2,46690             | 0,74962  | 0,00082  |

The problem is that some of the select items have positive elasticity of demand (I did not calculate the absolute value, to show this disproportion) that means that the demand curve does not descend, but even ascend with respect to higher price. I assume that the problem was that I did not change price of only one item, but I changed prices of half of the sample, which means I did not keep everything else constant. It might happen that there were some complements and if both increased in price, students tended to buy more of that one that was relatively cheaper and even there was increase in price there was also increase in number of purchased items.

As I already mentioned I decided to approximate data by an exponential curve  $P=Ae^{BQ}$ . Sometimes was rather easy and the results seemed to be valid as it is shown on the following picture (left picture), but unfortunately not all items could be approximated this way (right picture)



Picture 2. Examples of good and bad approximation.

I also tried to calculate elasticity of income and the result we can see in the following table.

Table 4

Elasticity of income of selected items

| Item          | Income = 10 000 CZK | Income = 3 000 CZK | Elasticity of Income |
|---------------|---------------------|--------------------|----------------------|
|               | Q                   | Q                  |                      |
| Car           | 62520               | 9486               | 1,37                 |
| Eurotel GO    | 8362                | 2131               | 1,10                 |
| Tatranka      | 901                 | 329                | 0,86                 |
| Roll          | 21326,55            | 9411,6             | 0,72                 |
| Sausage 100g  | 1422                | 659                | 0,68                 |
| Bus           | 143713              | 123893             | 0,14                 |
| Resident hall | 261                 | 284                | -0,08                |
| Catering      | 3637                | 4459               | -0,19                |

These results seem to look as it is expected. Higher elasticity has items as traveling by car or phone credit (Eurotel Go). Items like food (Tatranka, Roll, Sausage) or traveling by bus can be considered as normal goods. Finally items like living in campus or catering in university campus are considered like inferior and students with higher income would spend less money on it.