Doctoral School of General and Quantitative Economics

COLLECTION OF THESES

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Chapters from economic geography: horizontal differentiation

Ph.D. dissertation

Supervisor:

Gábor Benedek, PhD

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Department of Mathematical Economics and Economic Analysis

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1. Motivation and previous research

The mainstream economics regard the economy as a point, therefore the space and spatial properties of economy are totally neglected. This simplification can not be reconciled with reality, because the space must be took into account in business decisions. Thus, the goal of the economic geography to reform the economic thinking and prove that business interactions can not be separated from space without resulting grave consequences.

According to economic geography the fundamental assumption of product homogeneity in the mainstream economics is problematic. As two goods can not be in the same point, so their transportation costs have to be different, therefore the products can not be identical, ie. homogeneous. This also implies that the space is always behind the decisions of actors, as the products and the resources must somehow get to consumers.

This phenomenon, the product differentiation is a well-known fact in economics, therefore the economic geography is strongly connected to this topic, or to be more exact to the horizontal differentiation. It is understood under horizontal differentiation that consumers differentiate products due to their distinct preferences. There are consumers who like much more a product of a branch than other branches. However, the vertical differentiation describes a situation, when consumers rank products in the same manner. For example, the property of quality has a positive effect on utility of all consumers in the same way, ie. everybody likes the higher quality products.

The horizontal differentiation also can be divided into two groups: address and non-address models. The Hotelling and Salop model belong to the first group. The models with monopolistic competition, and thus the new economic geography too belong to the second group.

The new economic geography deals with macroeconomic problems, but the interactions between firms are simplified. Therefore, the investigations in behavior of companies are much closer to microeconomics, like the Hotelling framework. The dissertation is concerned in both topics.

The following two papers are part of the original thesis but are published in English, therefore we do not go into details about them:

- The spatial monopolies of supermarket chains in Hungary[1]

[1] http://pmr.uni-pannon.hu/articles/2_3_kelemen.pdf

- Note on Hotelling's webshop[2]

1.1 Parameter estimation for Hungary in a new economic geography model

Many new extensions were integrated into the framework of the new economic geography. Baldwin and Krugman (2004) or Hühnerbein and Seidel (2010) introduced tax competition between regions, Ago (2008) or Martinez-Giralt and Usategui (2009) connected it to the Hotelling model. According to Ottaviano (2010) the most important contribution to the discipline was the findings of Melitz (2003), who developed a model where companies have different productivity.

In the empirical literature many papers were also published, but the parameter estimation of the original model was slightly neglected. The two most important reasons of that the equations of the model are mostly non-linear and there may exist multiple equilibria. Of course there are still studies, which investigate this area. The literature offers possible ways to deal with this problem. One possibility is that the wage equation of the model is estimated as in Hanson and Gordon (2005), Brakman et al. (2004, 2006) or Bosker et al. (2010).

In this section we estimate the elasticity of substitution for 19 counties of Hungary using the wage equation. In order to ensure robust results we use four different estimation methods.

1.2 Simultaneous Hotelling model with Cobb-Douglas utility function

Hotelling's model (1929) was an important step in the development of spatial economics, though his main purpose was to analyze stability of competition. He extended Bertrand competition by the location of companies. The model uses horizontal differentiation and the prices and locations were determined sequentially. This leads to the fact that both companies are located in the market center. However these results were very plausible, d'Aspremont et al. (1979) demonstrated that there is no pure strategy Nash equilibrium in the model if the two companies are not in the center, but too close to each other. In other words, there is no tendency

[2] http://kozgazdasagtudomany.uni-corvinus.hu/fileadmin/user_upload/hu/kozgazdasagtudomanyi_kar/files/Koz_gazdasag/XII._evfolyam_3.szam_2017._junius/Koz-Gazdasag_2017_3_Jozsef_Kelemen.pdf

that shops want to relocate in the direction of the market center under these circumstances. Therefore the side authors suggested an alternative model with quadratic linear transportation costs instead of linear, where equilibrium exists everywhere. In this case companies tend to differentiate their products and move to the fringes of the market.

The original Hotelling model assumed that the prices are unconstrained, ie. every consumer in the market are willing to pay whatever price for a unit of the commodity. Lerner and Singer already noticed in 1937 that the price should have an upper limit to keep the model more realistic, because otherwise consumers' expenditure does not have boundaries. Furthermore they supposed simultaneous price and location determination when they investigated the original Hotelling model. Moreover Smithies (1941) proposed elastic demand because when companies are tending to the market center they can lose consumers on the fringes of the market. Therefore, a linear demand function was introduced and companies' behavior was investigated under four different strategies. Salop (1979) assumed an outside good in his famous circle model, where a finite reservation price appeared in the demand. Economides (1984) extended the original Hotelling model with the assumption of sufficiently low prices and found that companies behave in that case as local monopolies. They divert from each other and set monopoly prices in such a way that they do not interfere with each other. These results are in line with findings of Böckem (1994) under quadratic transportation costs. Hinloopen and van Marrewijk (1999) showed that a third case exists too for intermediate values of reservation price beside Hotelling's and Economides' result. It is a pure Nash equilibrium, companies compete and serve the total market. Woeckner (2002) found that optimal locations of companies ensure the social welfare maximization if transportation costs are quadratic and reservation prices are homogeneous in space. Previous models are usually based on exogenous reservation price, however, Lijesen (2013) applied endogenous reservation price with the introduction of a third company, a webshop.

Therefore we introduce a Cobb-Douglas utility function into the Hotelling framework. So the income can constrain the prices instead of the reservation price. We analyze the mechanisms of this model, whether we get new results.

1.3 E-commerce: with or without shipping fee?

The growing number and increasing sales of webshops validates the actual significance of internet shopping. It is a relevant question for a profit maximizing webshop how to implement shipping fee in pricing: shall the product price include shipping charge (free shipping) or the two prices should be separated (partitioned pricing), a shipping fee over the product price? The goal of this paper to give an analytical answer how to allocate a webshop total price between product price and shipping fee taking into account space through market size, delivery and transportation cost. Furthermore, which one is better: to offer a single price or separate shipping charge and product price?

According to the literature price allocation is quite common. Campanelli (2002) reported that a part of retailers use cost shifting, ie. shipping fee equals to the shipping cost. According to Tedeschi (2001) there is evidence that there are companies, which earn money from delivery and Enbysk (2005) found that almost the half of the retailers made profit on shipping charges.

Morwitz (1998) stated in the case of partitioned pricing that consumers can underestimate or underweight shipping fee. At the same time, some papers show the opposite. Schindler et al. (2005) investigated the consumer preferences in case of partitioned and free shipping price format and found that some consumers feel unfair, when they discover extra costs (like shipping and handling) over product price. They are called shipping charge skeptics preferring bundled format. But non-skeptics also exist, who prefer the separated price. This is in accordance with Hamilton and Srivastava (2008), who argued that consumers' price sensitivity is higher regarding cheap elements in partitioned price than to expensive ones.

Lewis et al. (2006) showed consumers' sensitivity to shipping fees and that the shipping fees have effect on order incidence and basket size. The use of free shipping increased order incidence rates, but also resulted in smaller order amounts. Moreover, the threshold-based free shipping lead to larger orders but effects on order incidences are negligible. Authors found that free shipping pricing mechanism was not profitable and lead to losses for firms in the study.

Dinlersoz and Li (2006) analyzed the internet book retailing industry to demonstrate internet retailers' shipping strategies. They introduced higher quality shipping, which is expressed by average delivery time. The authors found that sellers who offer lower base price tend to give higher shipping quality and ask lower shipping fee. This seems to be contradictory, which authors explain with imperfect consumer information.

Yao and Zhang (2012) investigated the product and shipping price, the allocating strategy and shipping time in an analytical and an empirical model. They found that free shipping tends to increase base price, ie. the total price does not only cover the product price, but a proportion of shipping charge. Moreover, the product price increases with on-time delivery probability, but shipping charge decreases with it.

Nevena et al. (2012) examined two recent, common shipping fees and their effects: the flat rate shipping and the threshold-based free shipping. Threshold-based free shipping is evaluated more favorably than flat rate when consumer wanted to buy above the threshold. If the value of basket was below the threshold, then the evaluation worsened.

Gümüş et al. (2013) investigated pricing strategies respect to shipping and handling fees. They looked for practical answers for enterprises: it is better to implement the shipping and handling fees into the product price or it is better to be separated, ie. which strategy should be chosen to enhance profit. Authors found that in the case of partitioned pricing the product price is lower but the total price with shipping and handling charge is larger than the free shipping price. According to their empirical results popular or risk taker companies choose free shipping strategy and change their price about 1.5 times more frequently, meanwhile partitioned pricing is used by mostly such companies, which deal with large and heavy products connected with high shipping fees. The shipping and handling fee was between 3-5% of the total price in the case of partitioned pricing. The authors' model takes into account that free shipping strategy lures more consumers resulting in higher demand, but revenues are lower due to the missing of shipping fee than partitioned pricing strategy.

2. Applied methods

2.1 Parameter estimation for Hungary in a new economic geography model

The following three –expenditure, price index and wage– equations by region are based on the results of Puga (1999). These together determine a short run of a new economic geography model.

$$e_r = \gamma(w_r L_r + r_r(w_r)K_r) + \frac{\mu}{1-\mu} w_r \varsigma_r L_r \tag{2.1}$$

$$P_r = \frac{\beta\sigma}{\sigma-1}\left[\frac{1}{(1-\mu)\alpha\sigma}\sum_{\tilde{r}=1}^{R}\varsigma_{\tilde{r}} L_{\tilde{r}} w_{\tilde{r}}^{1-\sigma(1-\mu)} P_{\tilde{r}}^{-\mu\sigma}\tau_{r\tilde{r}}^{1-\sigma}\right]^{1/(1-\sigma)} \tag{2.2}$$

$$w_r = \left(\frac{\beta\sigma}{\sigma-1}\right)^{1/(\mu-1)} P_r^{\mu/(\mu-1)}\left[\frac{\beta}{\alpha(\sigma-1)}\sum_{\tilde{r}=1}^{R}\tau_{\tilde{r}r}^{1-\sigma} e_{\tilde{r}} P_{\tilde{r}}^{\sigma-1}\right]^{1/(\sigma(1-\mu))} \tag{2.3}$$

The three endogenous variables are the expenditure (e_r), the price index (P_r) and the wage (w_r) of a region. R is the number of regions, σ is the elasticity of substitution, γ is the weight of the composite good in consumer utility, μ is the weight of composite product in the production function of companies, β is the marginal cost and α is the fixed cost. K_r and L_r are the stock of capital and labor of a region. The transportation cost between two regions is $\tau_{\tilde{r}r}$, ς_r is the share of industrial workers of a region. The unit capital profit of is $r_r(w_r)$.

In order to estimate the parameter of elasticity of substitution it is not necessary to use all equations. The expenditure equation is linear, but it does not include the variable wage. The price index equation is not suitable for estimation, as well, because the price index is on the both side of (2.2).

There are different ways in estimating. Hanson (2005) suggested that a NEG model with housing services should be used and real wages should equalize across regions. Thanks to the first assumption the price index can be eliminated. However the second assumption seems too strong, because it would implies a long run process. Brakman et al. (2006) try to estimate the price index based on the model equation. Fortunately we could collect price indices by regions, so we can estimate directly the equation.

$$ln(w_{rt}) = \kappa + \frac{\mu}{\mu - 1} ln(P_{rt}) + \frac{1}{\sigma(1-\mu)} ln\left[\sum_{\tilde{r}=1}^{R} \tau_{\tilde{r}r}^{1-\sigma} e_{\tilde{r}t} P_{\tilde{r}t}^{\sigma-1}\right] + \sum_j \alpha_j X_{jrt} \quad (2.4)$$

The time index is t, the constant is κ and λ_r is the share of workers in region r. We use fixed effects method to control the differences between regions. X_{jrt} are those external variables which can not be explained by the NEG model.

The data is based on the database of Hungarian Statistical Office. The time series are available by regions for the years 2000-2016, which results 340 observations. We use the 19 Hungarian counties as regions, moreover Pest and Budapest are separated so we have overall 20 regions.

The wage is the average gross earnings of employees and expenditure is the GVA, in both cases corrected by inflation. The external exogenous variables are the following: unemployment rate and length of public ways. The price index is the industrial price index. The distance data were downloaded from the Google Maps.

We regress the equation using four different estimation methods with fixed effects on panel data: ordinary least squares (OLS), two-stage least squares (2SLS), OLS and 2SLS with exogenous variables.

2.2 Simultaneous Hotelling model with Cobb-Douglas utility function

The model uses elements of the popular Dixit-Stiglitz framework and integrates it with the Hotelling model's approach. Two companies decide simultaneously about prices and locations and for the interest of tractability, a simple mark-up pricing is introduced – though this assumption can be realistic in some cases too. The model framework can be interpreted like two similar sized supermarkets trading with similar varieties of products. Both companies try to supply the maximum variety of goods, therefore firms offer the same products, so their acquisition costs could be also equivalent. Consequently, a rational consumer chooses the closest shop assuming to have similar prices.

The model investigates the behavior of two companies in a unit long space. In this imaginary city consumers are located equidistantly and choose only one shop, where they buy certain products. They have a Cobb-Douglas utility function, where the first good is a composite product, which is expressed by a CES function with parameter $\sigma > 1$.

$$U(x) = Q(x)^\gamma S(x)^{1-\gamma}, \quad \text{where} \quad Q(x) = \left(\int_0^{v_R} q(v,x)^{\frac{\sigma-1}{\sigma}} \mathrm{d}v\right)^{\frac{\sigma}{\sigma-1}} \tag{2.5}$$

The resident, who lives at location x buys from the company R, who sells number of product variety v_R. Moreover, the resident at location x consumes quantity $q(v,x)$ from the product v and $Q(x)$ from the composite good. Besides that he or she consumes quantity $S(x)$ from the other product too, to which is not connected transportation cost. It can be interpreted as savings, of which the price, P_S is exogenous. In this case using price index $P_R = (\int_0^{v_R} p_r(v)^{1-\sigma} \mathrm{d}v)^{\frac{1}{1-\sigma}}$ and transportation cost τ, the disposable income can be written as

$$Y(x) = P_R Q(x) + P_S S(x) = y - \tau |x_R - x|. \tag{2.6}$$

Parameter y is the income of the consumer, and the distance is calculated by absolute value function in order to keep the model analytically relative simple. Hence, the usual budget constraint, the disposable income and the difference of income and transportation cost are equal. As a result of utility maximizing, the demand of product v at location x can be expressed as the following

$$q(v,x) = \frac{p_R(v)^{-\sigma}}{P_R^{1-\sigma}} \gamma Y(x). \tag{2.7}$$

There are two companies, A and B and it can be supposed without violating generality, that $x_A \leq x_B$. Firms compete with each other, maximize their profit and we assume that product diversity is exogenous.

Let $\tilde{x}$ be the location of the marginal consumer, who is indifferent to buy from company A or B

$$\tilde{x} = \begin{cases} -\frac{y}{\tau} + \frac{P_A^{-\gamma} x_A - P_B^{-\gamma} x_B}{P_A^{-\gamma} - P_B^{-\gamma}} & \text{if } \tilde{x} < x_A < x_B \\ \frac{P_A^{-\gamma} - P_B^{-\gamma}}{P_A^{-\gamma} + P_B^{-\gamma}} \frac{y}{\tau} + \frac{P_A^{-\gamma} x_A + P_B^{-\gamma} x_B}{P_A^{-\gamma} + P_B^{-\gamma}} & \text{if } x_A \leq \tilde{x} \leq x_B \\ \frac{y}{\tau} + \frac{P_A^{-\gamma} x_A - P_B^{-\gamma} x_B}{P_A^{-\gamma} - P_B^{-\gamma}} & \text{if } x_A < x_B < \tilde{x}. \end{cases} \tag{2.8}$$

Every product has a fixed cost and the distribution of population is homogeneous, ie. only one inhabitant lives at a location. The companies use mark-up pricing as in Grant and Quiggin's paper (1994), $c_R(v) = \rho_R(v) p_R(v)$, where ρ is the mark-up. For simplicity, we suppose, that there is only one mark-up ($\rho_R(v) = \rho_R$) per shop, because the companies do not make difference or discriminate between product or consumer groups. Therefore, firms have one decision variable by price. The price index of cost is $C_R = (\int_0^v c_R(v)^{1-\sigma}\mathrm{d}v)^{\frac{1}{1-\sigma}}$ and so the connection between the price and cost indices is $P_R = \frac{C_R}{\rho_R}$

Moreover, supposing both companies face the same product structure $c = C_A = C_B$ and $v_A = v_B$, so the two companies will not compete in product diversity. Shops of similar size supply the same spectrum of goods decreasing the other company's competition advantage. So we have to maximize the profit under the budget constraint, where l is the leftmost and r the rightmost consumer of the company:

$$\pi_R = \gamma(1 - \frac{c}{P_R})(y(r-l) + \tau x_R(r+l) - \frac{\tau}{2}(l^2 + r^2) - \tau x_R^2). \qquad (2.9)$$

2.3 E-commerce: with or without shipping fee?

In order to investigate pricing strategies, free shipping and partitioned pricing. We applied Kelemen (2017b) as a starting point, which is a modified version of Lijesen (2013). These models use a Hotelling framework with endogenous reservation price.

There are n number different sized, δ^i long, linear markets or imaginary cities. On the one side two regular shops are in every market i, the first is called A^i and the second one is B^i. Essentially A^i and B^i do not compete, because they are separated by the webshop's consumers in space. Their locations are x_{A^i} and x_{B^i}. On the other side there is only one webshop in all the n markets. In a two stage game A^i and B^i first determine their locations in the imaginary cities and after that the two shops and webshop set prices (p_{A^i}, p_{B^i} and p_0) for the same product.[1]

The consumers have to bear a transportation or travel cost ($\tau > 0$) over product price if they want to buy from the regular shops, while the webshop faces a fixed delivery cost ($\theta > 0$) if consumers buy online. However the webshop can set a shipping fee (ϕ) for the consumers to cover the delivery cost.

The market is divided by shops in such a way that from left to the right the market is owned in order: webshop, shop A^i, webshop, shop B^i and again webshop. The fringes and the center of the market are served by the webshop, because its price is low enough for assuring that. The consumer buys in the shop, where the product is cheaper, therefore there exists marginal consumers, who are indifferent in the choice of shopping between a regular shop and the webshop. On the other side the marginal consumers separate the demand of the shops. The arrangement of shops is ensured by a Nash equilibrium which exists according to Economides (1984). The

[1] Zero subscript refers to the webshop.

price of the webshop acts as a reservation price for the regular shops, so they can behave as local monopolies.

If we want to determine for example the location of the first marginal consumer, ie. on the left side of company A^i, then we have to solve the next equation: $p_0 + \phi = p_{A^i} + \tau(x_{A^i} - x_{0A^i})$. It expresses the price and cost equality for the marginal consumer in location x_{0A^i}, ie. the price of the webshop with delivery cost equals with the price of company A^i plus the transportation cost to the regular shop. However this formula now differs

$$p_0 + \psi_1\phi + \psi_2(\phi - \kappa p_0)^2 = p_{A^i} + \tau(x_{A^i} - x_{0A^i}). \tag{2.10}$$

The shipping fee is actually not an evident price component for the consumers, as they are not perfectly rational or it is also possible that the cost of information is too expensive. This alter the behavior of consumers and offset the location of the marginal consumer.

The shipping fee can be divided into two terms on the left side of (2.10). The first is similar to the delivery cost, which was also presented in the original model. The parameter ψ_1 expresses the extent the consumer perceives the shipping fee, when it is not included in the product price. It is ranged between 0 and 1, and when it is zero the extra cost is irrelevant for the consumer, and when it is one, then the consumer acts totally rational as in the original model. But if the webshop knows this parameter, it gives higher shipping fee and lower product price, because a part of the consumers will not notice this tactic. So in this way the webshop can positively influence both the demand side and its profit. However this mechanism alone could result in an unbalanced price structure, for example in the most extreme case the product is free and the shipping fee is the only price. Clearly, this could make a part of the consumers unsatisfied leaving the webshop and they would search for other opportunities. So the second term of the shipping fee tries to cover a group of consumers, who feel that the shipping charge is unfairly high (or maybe pointlessly low) and therefore, they do not accept the offer of the webshop. The parameter ψ_2 refers to the sensitivity of this term and the expression in the brackets is the deviation of the actual shipping fee from the fair shipping charge, which is κ percentage of the product price. Therefore κ can be called fair shipping fee ratio, and after Schindler et al. (2005) ψ_2 the proportion of shipping charge skeptics ($0 \leq \psi_2, \kappa \leq 1$).

Rearranging (2.10) we can express x_{0A^i} and similarly the other three locations of marginal consumers

$$x_{0A^i} = \frac{1}{\tau}(\tau x_{A^i} + p_{A^i} - p_0 - \psi_1\phi - \psi_2(\phi - \kappa p_0)^2) \tag{2.11}$$

$$x_{A^i0} = \frac{1}{\tau}(p_0 + \psi_1\phi + \psi_2(\phi - \kappa p_0)^2 - p_{A^i} + \tau x_{A^i}) \tag{2.12}$$

$$x_{0B^i} = \frac{1}{\tau}(\tau x_{B^i} + p_{B^i} - p_0 - \psi_1\phi - \psi_2(\phi - \kappa p_0)^2) \tag{2.13}$$

$$x_{B^i0} = \frac{1}{\tau}(p_0 + \psi_1\phi + \psi_2(\phi - \kappa p_0)^2 - p_{B^i} + \tau x_{B^i}). \tag{2.14}$$

The first equation means the indifferent consumer between the webshop and on the left side of regular shop A^i. The other equations are analogous.

The demand for the first shop in the market i can be expressed the following way

$$q_{A^i} = x_{A^i0} - x_{0A^i} = \frac{2}{\tau}(p_0 + \psi_1\phi + \psi_2(\phi - \kappa p_0)^2 - p_{A^i}). \tag{2.15}$$

We can suppose zero costs without loss of generality, so the profit is

$$\pi_{A^i} = p_{A^i}q_{A^i} = p_{A^i}\frac{2}{\tau}(p_0 + \psi_1\phi + \psi_2(\phi - \kappa p_0)^2 - p_{A^i}). \tag{2.16}$$

Regular shop prices can be determined from the first order condition. Because they does not depend on i, we can change to a general subscript, r as regular

$$p_r = p_{A^i} = p_{B^i} = \frac{p_0 + \psi_1\phi + \psi_2(\phi - \kappa p_0)^2}{2}. \tag{2.17}$$

Furthermore (2.15) and (2.17) implies that in optimum

$$q_r = q_{A^i} = q_{B^i} = \frac{2p_r}{\tau}. \tag{2.18}$$

In the market i, B^i and A^i are symmetrical, moreover, further shops in other markets are similar to these two shops, so the demand and the prices are the same for all regular shops. Clearly, the two shops in the market i gain $2q_r$ from the demand and the webshop gains the rest. The size of market i is δ^i and so we can determine the profit of the webshop in all the n markets

$$\pi_0 = \sum_{i=1}^{n}\left((p_0 - \theta^i)(\delta^i - 2q_r)\right). \tag{2.19}$$

3. Results of the thesis

3.1 Parameter estimation for Hungary in a new economic geography model

Table 3.1: Estimation results

Variables	Estimation 1 (NLS)	Estimation 2 (2SLS)	Estimation 3 (NLS+exo.)	Estimation 4 (2SLS+exo.)
κ	2.301***	6.418***	4.722***	9.667***
	(0.359)	(1.135)	(0.452)	(0.937)
σ	9.064***	13.397***	8.828***	11.365***
	(0.256)	(1.765)	(0.228)	(1.21)
length of	-	-	-0.384***	-0.665***
public ways	-	-	(0.048)	(0.111)
adj. R^2	0.533	0.376	0.718	0.492
N	320	320	320	320

* 0.1, ** 0.05, *** 0.01 significance level
Under the coefficients in the brackets are their standard deviations. In the third and fourth estimation: $\delta' = 0.07782$.
Instruments of the second and fourth estimation: constant, precipitation, temperature, west, number of drugstores, length of public ways, unemployment and regional dummy (only in the fourth estimation)
Source: HCSO, Google Maps

- The elasticity of substitution is significant in all cases and greater than one as the theory suggested. The estimated values are between 8 and 14 in the four different cases. These findings are similar to the literature, but there the values are typically lower than 10.

- The sign of unemployment rate is opposite as the literature expects, so we left from the estimation. The length of public ways has negative sign, which can be explained by the higher supply of labour so the companies can offer lower wages.

- Kelemen (2013a) gives two interpretations for the reason that the value of the elasticity of substitution is higher compared to the literature. First the Hungarian consumer preferences are still influenced by the previous, socialist regime. At that time there was not variety of the products, and the consumers were accustomed to that they could not choose. The second explanation is connected to the literature, which mostly dealt with developed countries, meanwhile Hungary is still a developing country. In a big and rich country there is higher possibility for higher product diversity due to the size of the demand, but in Hungary this is not the case.

3.2 Simultaneous Hotelling model with Cobb-Douglas utility function

- The results are based on the ratio of income and transportation cost, which is key element of the model.

- Local monopolies ($0 < \frac{y}{\tau} \leq \frac{1}{4}$): As Economides (1984) demonstrated, the profit of local monopolies is independent from their location when their demand does not cross each other's.

$$\pi_R = \gamma \left(1 - \frac{c}{P_R}\right) \frac{y^2}{\tau} \rightarrow \gamma \frac{y^2}{\tau}. \tag{3.1}$$

- Minimum differentiation ($1 \leq \frac{y}{\tau}$): The companies will be located in the center due to the constraints ($r_A \leq \frac{1}{2}$ and $l_B \geq \frac{1}{2}$). However, prices are equal to marginal cost because the two companies are in the same location, so they start Bertrand competition in prices only. As in article of d'Aspremont et al. (1979), we can not say anything about the tendency of the relocation in the non stable Nash equilibrium locations due to undercutting. This means that the principle of minimum differentiation is not valid in this model, either.

- Intermediate differentiation ($\frac{1}{4} < \frac{y}{\tau} < 1$): The locations are symmetric, their sum is one, moreover, the prices are equal too and the solution is a Nash equilibrium.

$$x_A = \frac{1}{6} + \frac{y}{3\tau}, \tag{3.2}$$

$$x_B = \frac{5}{6} - \frac{y}{3\tau}, \tag{3.3}$$

$$P_A = P_B = c\left(1 + \frac{10\frac{y}{\tau} - \frac{5}{4} - 2(\frac{y}{\tau})^2}{\gamma(4\frac{y}{\tau} - 1)^2}\right). \tag{3.4}$$

- When we would like to interpret (3.2),(3.3) and (3.4), first it is worth taking into account the constraints of location. On the one hand, companies can not get closer to the end points of the imaginary city less than $\frac{1}{6}$. This is the case, when the ratio of income and transportation cost tends to be zero. But according to the constraints $\frac{1}{6}$ can not be reached in the framework of the model, this value is not binding, so the location of company A is between quarters and center. If the ratio increases, than companies will get closer to the center.

- The price decreases as the transportation cost reduces or the income increases. This leads to stronger competition, because more consumers can choose the other shop. A lower price can lure them much easier to the other shop because firms get also closer. Overall, the gain on prices can compensate consumers' loss on higher transportation costs.

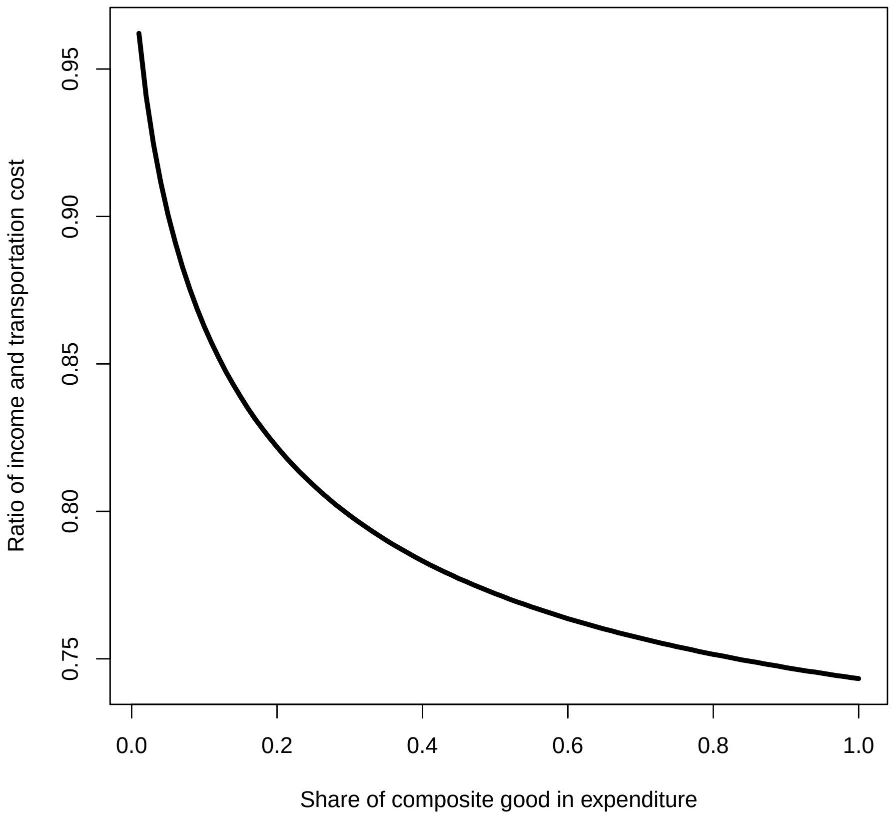
- Undercutting: To check whether the Nash equilibrium is stable, ie. there is no possibility of undercutting, the profit function must be investigated not just in the case, when the marginal consumer is between the two shops, but also when it is out of that range. It can be easily shown that the range of $\frac{1}{4} < \frac{y}{\tau} \leq \frac{2}{5}$ ensures stable optimum, because companies are so far from each other that there does not exist such positive price where the undercut is possible. First a bit above $\frac{2}{5}$ there are such positive prices for which undercut can be realized but the growth of demand can not cover necessarily the shrink of revenue. So, significantly higher income and transportation cost ratio requires that companies move close enough to each other and offer substantially higher prices. These together can establish the undercutting strategy.

- If γ equals one, the consumer does not save and spend the whole disposable income on the composite good. In that case the highest $\frac{y}{\tau}$ ratio is around 0.7433, where the stable Nash equilibrium exists, above that level equilibrium is unstable. As γ decreases the possibility of undercutting lowers. Consumers spend much less on the composite good and it is like $\frac{y}{\tau}$ would be lower. The level of the possible highest ratio (m) increases because the good is not so important for consumers as in the case of higher γ values.

- Thus, the intermediate case can be divided into two arrangements. The first is the stable intermediate case, when the ratio of income and transportation cost is between $\frac{1}{4}$ and m, where m is the highest level of $\frac{y}{\tau}$ which ensures stable

Nash equilibrium. The figure 3.1 depicts these values. The second case is the non-stable solutions between m and 1, where no pure Nash equilibrium exists due to undercutting.

Figure 3.1: Expenditure share of composite good (γ) and last income and transportation cost ratio level, where Nash equilibrium (m) exists



- Comparison with previous results from the literature : The results show similarities to the original Hotelling framework. The findings of the literature are summarized by Hinloopen and Marrewijk (1999). The authors suggested determining $\alpha = l/\frac{v}{\tau}$, the size of the market (l) in the ratio of the effective reservation price to identify easily different cases. In the new model presented in this paper, the length of the imaginary city is fixed ($l = 1$) and the parameter of income plays the role of the reservation price ($v = y$). Table 3.2 compares actual results with the previous ones. In both cases it can be observed that local monopolies appear at low values of α. However, they emerge rarely in the new model, because larger demand is needed to the monopoly behavior due

Table 3.2: Comparing results

	New model ($\gamma = 1$)
$4 \leq \alpha$	Local monopolies
$1.35 \leq \alpha < 4$	Competition between quarters and center
$1 < \alpha < 1.35$	Non stable competition
$\alpha \leq 1$	Hotelling case

	Hinloopen and Marrewijk (1999)
$2 \leq \alpha$	Local monopolies
$\frac{4}{3} \leq \alpha \leq 2$	Competition at quarters
$\frac{8}{7} \leq \alpha \leq \frac{4}{3}$	Competition between quarters and center
$0 < \alpha < \frac{8}{7}$	Hotelling case

to its fixed size. In the case of intermediate values of α companies compete with each other and are located between quarters and center. The higher values of α can be interpreted as in the original Hotelling model. In the market center there is also a Bertrand competition, but near to the central locations it can not be said anything about the relocation tendency of companies.

3.3 E-commerce: with or without shipping fee?

- Solutions exist for the Nash and Stackelberg competition, but differences are not so substantial: Nash case tries to capture the similar size shops, while in the Stackelberg case the size of the webshop is bigger than regular shops and it has stronger market power.

- We demonstrate the changes in parameters of partitioned pricing, because the shipping fee strategy is the special case of that. All prices – regular shop prices, free shipping price, product price and shipping fee in separated pricing – are positively correlated with the size of the market (δ^i). It is straightforward that as the demand grows the prices could be raised by enterprises and so profits also improve.

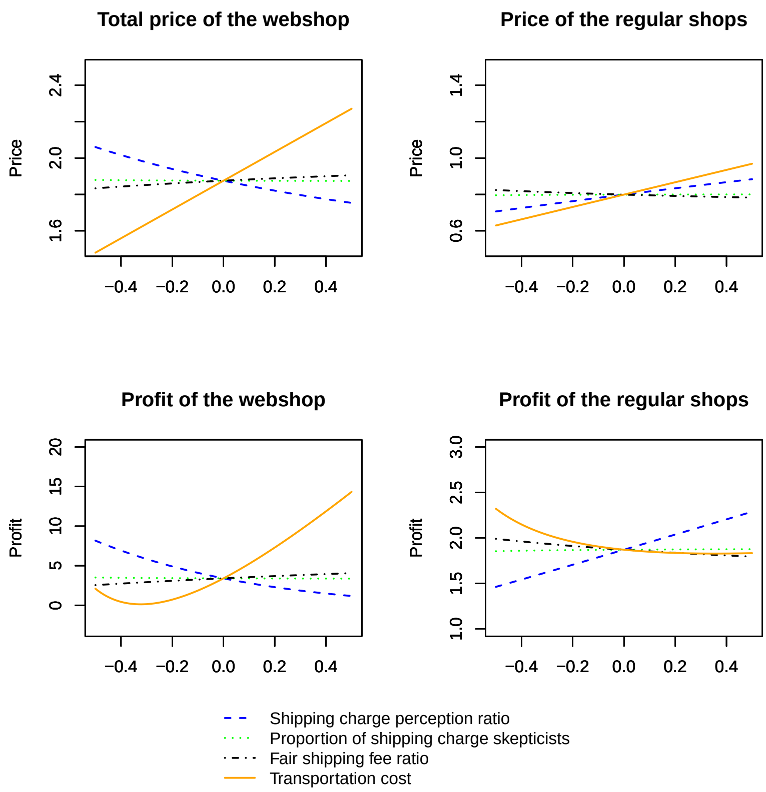
- The higher delivery cost (θ^i) increases the costs of the webshop, therefore, the prices have to be increased to maintain profitability. Not just the product price, but shipping fee can also be raised, because the higher product price leads to higher fair shipping fee. The regular shops follow the price increase of the webshop, because their demand expand on the loss of the webshop and they gain extra profit. However, the webshop can not compensate the diminishing demand, so its profit falls back.

- The transportation cost (τ) has opposite profit effects as delivery cost. It's growth influences negatively the demand of regular shops, so more consumers buy from the webshop. The webshop raises the prices, which is followed by regular shops. At the same time, the profit of the webshop increases, while the profit of the regular shops decrease.

- Market size and transportation cost are connected in formulas (D), so if there was not any transportation cost, then the market size effect would disappear. In this case we might wonder, why delivery cost exists. The reason behind that is to keep the model as simple as possible. Earlier it was stated that transportation cost belongs to consumers as it is a travel cost, while delivery costs to the webshop in the model. Now let parameters have common factors. By expressing this, we can resolve the contradiction previously stated. For example, let $\tau(p_\tau) = p_\tau t_\tau$ and $\theta(p_\tau) = p_\tau t_\theta(i)$, where p_τ is a composite index of transportation costs (fuel etc.). This can ensure that diminishing price of transportation has a negative impact on both costs.

- Hence, the growth of fuel, electricity and other transportation cost prices lead to the increase in transportation and delivery cost. It induces directly the increase of the demand of the webshop at the expense of regular shops. So the webshop can raise its price, which is also followed by regular shops. The regular shops can make more profit from this case, because the consumers are willing to buy at any price in the model and so they never quit the market. However, the cost of the webshop also becomes higher due to higher delivery cost, but its profit depends on the ratio of transportation and delivery cost. If the effect of delivery cost is much more significant, it would generate loss to the webshop, but in the opposite case the profit of the webshop improves.

Figure 3.2: Prices and profits of the webshop and the regular shops affected by percentage change in parameters



Note: On the horizontal axis the different lines demonstrate the changes in the selected parameter while other parameters are fixed. On the horizontal axis show the resulted prices or profits. In the case of webshop the price includes the shipping fee. In extreme percentage cases solutions may not exist because conditions are not satisfied.

- Specific factors of the partitioned pricing also play an important role. Figure 3.2 demonstrates the effect of changes in shipping charge perception, proportion of shipping charge skeptics and fair shipping fee ratio. The increase of the shipping charge perception ratio (ψ_1) results in lower total price for the webshop due to the loss of demand. The loss is related to the shipping fee, because more consumers notice the significance of it. Therefore, the webshop tries to restructure prices, increases the product price, while lowers the shipping fee. Overall, these factors lead to the decrease of profit. The regular shops win on this because many new consumers choose them, so it is easy for them to raise prices and gain extra profit.

- The higher share of shipping fee skeptics (ψ_2) is analogous to the previous case. The webshop must lower total price in order to stop losing many consumers, but cannot avoid decrease of profit. This case is again beneficial to the regular shops: they can raise product price to improve profitability.

- The increase of fair shipping fee ratio (κ) gives the opportunity to the webshop to set higher shipping fee. On the other hand, product price is lowered in such a way, that the increase of total price would be not so high. So the webshop gains extra profit, while profit change of the regular shops is not obvious.

- One can see easily that in the case separated pricing the product price is lower, but the total price is greater than the free shipping bundle price. The results are in-line with findings of Gümüş et al. (2013) and Yao and Zhang (2012).

- The profit is higher in the partitioned pricing case than in free shipping, so it implies that every webshop should use partitioned pricing. But it is important to note that the webshop knew all relevant market information, also parameters during its profit maximization. However, in reality these are hard to collect and are also costly. So, if a webshop makes an improper decision, then the profit can be lower than in the free shipping case. Therefore, the choice of pricing strategy must be based on the knowledge of the market. For a new starting webshop without any information about market structure, a free shipping strategy seems to be preferable.

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