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Demand Analysis by Rotterdam Model: An Assessment of Urban China

Rotterdam Modeline Göre Talep Analizi: Kentsel Çin'in Değerlendirilmesi

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ABSTRACT

This study analyzes food demand of household by income category in Heilongjiang, Shandong and Henan provinces in urban China. The data set includes household level observation on food consumption in urban areas. The data is derived from National Bureau of Statistics (NBS) which is conducted as a national household annual survey. It includes: income and households' expenditure. The annual survey also covers social security participation, house pricing, production investment, and some other variable related with income distribution. Therefore, the data set is appropriate for demand analysis. First 6 different food categories are chosen which are grain, meat products, aquatic products, dairy products, fresh fruits, and others. Also, households are categorized by individuals' yearly income level as low-, and high-income classes, using these three provinces data. The Rotterdam model is applied in the analysis of data set. The model is explained theoretically then applied using SAS 9.4 software.

Keywords: Demand Analysis, Elasticity, Rotterdam Model

ÖZ

Bu çalışma Çin'in Heilongjiang, Shandong ve Henan eyaletindeki hanehalkı gıda talebini gelir gruplarına göre analiz etmektedir. Veri seti, kentsel alanlarda hanehalkı düzeyindeki, gıda tüketim verilerinden oluşmaktadır. Veriler, ulusal hane halkı yıllık anketi olarak yürütülen Çin'in Ulusal İstatistik Bürosu'ndan (NBS) elde edilmiştir. Bu veriler gelir ve hanehalkı harcamalarını içermektedir. Söz konusu yıllık veriler ayni zamanda istihdam anketleri, sosyal güvenlik katılımı, konut fiyatları ve gelir dağılımını etkileyen faktörleri içermektedir. Bu nedenle, veri seti talep analizi için uygundur. Söz konusu veri setinden 6 farklı ürün ve ürün grubu seçilmiştir, bu ürünler; tahıl, et ürünleri, deniz ürünleri, süt ürünleri, taze meyveler ve diğer gıda ürünlerini kapsamaktadır. Ayrıca, Çin'in kentsel hane halkı anketi verileri kullanılarak, bireylerin yıllık gelir düzeyi düşük ve yüksek gelirli sınıflar olarak sınıflandırılmaktadır. Veri setinin analizinde Rotterdam modeli uygulanmaktadır. Model teorik olarak anlatıldıktan sonra SAS 9.4 programı kullanılarak uygulanmıştır.

Anahtar Kelimeler: Talep Analizi, Esneklik, Rotterdam Modeli

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I Introduction

The purpose of the current study is analyzing theoretically and empirically supply and demand equations for chosen 6 products in Heilongjiang, Shandong and Henan provinces in urban China. For this purpose, I examine the urban China's province data using Seemingly Unrelated Regression Estimation (SUR)- for Rotterdam Model. The data set is taken from It is taken from National Bureau of Statistics (NBS) which is conducted a national household annual survey. To analyze of the model SAS 9.4 is applied[1].

There are many studies in the literature capturing household demand and especially agricultural good demand all around the world. For example, Andreyeva et al. (2010) analyzed own-price elasticity estimating for major food categories based on 160 studies conducted in the United States. Green et. al (2013) quantified the relationship between food demand by income category. The analysis results of the study show own-price elasticities of edible goods in 162 countries. Nevertheless, some studies' results are contradicted in terms of elasticity's estimation in Chinese Market. For instance, one of the recent study results showed that dairy products' own price demand elasticity is 0.24 for Urban China (Zheng and Henneberry, 2011) while Liu and Zhong, (2009) represented a high own price elasticity of demand for dairy product which is 1.12. Thus, different econometric and economic analysis methods may impact the results.

Chen et. al (2015) examined a meta-analysis of food and agricultural demand elasticities of Chinese' products. The authors estimated the own price elasticity, income elasticity and cross-price elasticities of demand in food and agricultural markets. Their study results show that the food products demand elasticities negatively related with per capita income. Meaning that when per capita income rises, income elasticity of food products decreases. The major declines are observed in the alcohol and tobacco, products while smaller decreases are detected in the livestock products.

All in all, the aim of this study is to examine household demand of Urban China. In this respect, the current data set is retrieved from National Brue of Statistics in 2017. Therefore, the study specifically chooses Heilongjiang, Shandong and Henan in urban China's households demand. The reason is that Shandong has pretty high gross domestic product (GDP) since it is one of the China's major provinces. Also, Shangdong is one of the most wealth province respects to its district since it is positioned on the China Sea while Henan is located in the central of China. Also, the other province Heilongjiang is the most north part of the China. For this reason, the estimation of urban households' demand using Heilongjiang, Shandong and Henan provinces may help to understand Urban China's household demand pattern.

[1]The Rotterdam Model and Almost Ideal Demand System Model SAS code can be accessible at Guneysu-Atasoy (2018)' study.

II Data

The data set includes household level observation on food consumption in 2017 in the Heilongjiang, Shandong and Henan provinces for prediction of the Urban China's households demand. It is derived from National Bureau of Statistics (NBS) which is conducted as a national household annual survey. The survey is administered directly by NBS and includes: income and expenditure of the household. In addition it covers employment information, house pricing, production investment, and some other variable related with income distribution. The survey is operated choosing houses randomly, then households are determined. After that, it is sampled with stratified multi stage sampling method under population scale (NBS of China, 2018).

First, 6 different food categories are chosen which are grain, fresh fruits, meat products, aquatic goods, dairy products, and others. Also, households are categorized by individuals' yearly income level as low-, and high-income categories, applying Heilongjiang, Shandong and Henan provinces in the China urban household survey data. For income category, disposable income is chosen. Disposable income is remaining part of total yearly income after deduction of taxes and social security charges.

III Method

For the present study, the Rotterdam Model is chosen to be applied in the analysis. The Rotterdam Model is one of the commonly used models while estimating true elasticity in the literature. The Rotterdam Model, both the forecasting consumer demand of chosen products and estimation of true elasticities delivers very sufficient results. Some studies in the literature compare the Rotterdam Model and nonlinear AIDS models. In these studies, use Monte Carlo technique to evaluate the performances of the models in terms of their true elasticity of demand estimations. Some of the studies prefer the Rotterdam Model in terms of true elasticities of demand (Barnett and Seck, 2008). Therefore, the chosen 6 different products' demand and elasticities are estimated by the Rotterdam Model. The model specification is explained by follows;

The model was acquired by Barten and Theil (1960, 1965 and 1979). It is considered a local adjustable function form.

- To start with a demand equation implied by utility maximization subject to constraint.

$$\bar{Q}_i = Q_i(P_1, P_2, P_3, P_4, \dots P_n, Y) \qquad i = 1,2,3 \dots . n \qquad (1)$$

- Where Qi is the quantity of the product i, and P_1, through Pn are prices of other products and Y is income.

- The Rotterdam model is obtained as follows

$$dlnQ_i = \left(E^*_{i,1} - R_1.A_i\right)dlnP_1 + \left(E^*_{i,2} - R_2A_i\right)dlnP_2 + \cdots + \left(E^*_{i,n} - R_n.A_i\right)dlnP_n + A_i dlnY \quad (2)$$

- It can also be written,

$$R_i dlnqi = \theta_{i,1}dlnP_1 + \theta_{i,2}dlnP_2 \ldots . + \theta_{i,n}dlnP_n + M_i dln(\tfrac{Y}{P}) \quad (3)$$

Then, Rotterdam Model is

$$R_i dlnqi = \sum \theta_{i,1} dln\, P_j + M_i dln(Y/P) \quad (4)$$

Table-1: Elasticities of the Rotterdam Model

Elasticities	Equations
Income Elasticity	$\boldsymbol{A_i = M_i/R_i}$
Price Elasticity by Hicksian	$\boldsymbol{E^*_{i,j} = \theta_{i,j}/R_i}$
Price Elasticity by Marshallian	$\boldsymbol{E_{i,j} = E^*_{i,j} - R_jA_i}$

IV Analysis Results

All of equations are solved using SAS 9.4 software according to Seemingly Unrelated Regression test result (for Rotterdam model). Table-2 represents summary statistics of chosen products group. For the briefness and accuracy of the study not all of the system of SAS output are represented. The necessary information and elasticity is represented to make the study more coherent for the readers.

Hicksian and Marshallian elasticity are shown in the Table-3 and Table-4 in sequence. In conditional demand system, the expenditure is treated as exogenously since group expenditure change in the response of a change in prices of the products and income. These conditional elasticities are converted to unconditional ones. The conditional Hicksian elasticities give the own price elasticity of all 6 goods which are negative in the table. For instance, rice, meats and aquatic products consumption decreases by 0.75%, 0.63% and 0.64% respectively, when these three goods prices increase by 1%. The own price elasticities for these three goods are also negative for the Conditional Marshallian elasticities. It is also logical that when the price of the goods goes up, consumption of the goods decreases.

Table-2: Summary Statistics of Chosen products

Variables	Mean	Standard Deviation	Minimum	Maximum
Rice	53.15	31.17	21.45	93.07
Meat Products	25.10	13.09	11.62	40.76
Aquatic Products	18.23	10.71	6.15	29.08
Dairy Products	13.41	10.75	4.05	24.01
Fresh Fruits	40.11	25.69	25.81	61.75
Others	14.75	10.83	3.15	31.62

In addition, the cross price elasticities of Hicksian are positive. As an example, the meats (pork, beef, and mutton) and aquatic products are net substitutes. The Marshallian elasticities eij=eij*-RjAi, include income impacts. Therefore, the Hicksian'sown price elasticities are smaller than the Marshallian's own price elasticities. However, the Marshallian cross-price elasticities results are changeable. It may be smaller or larger in comparison to the Hicksian cross-price elasticities in accordance with income (Ai>0, Rj>o and eii*<o then eii>eii*-RjAi). When income increases by 1%, for meats, the group expenditure (includes rice, meats, aquatic products, fresh fruits, others) goes up by 4%.

Table-3: Conditional Hicksian Elasticity

Quantities	e_{ij}* (Conditional Hicksian Elasticity) Prices							
Variables	**Rice**	**Meat Product**	**Aquatic Products**	**Dairy Products**	**Fresh Fruits**	**Others**	**Expenditure Elasticity**	**Income Elasticity**
Rice	-0.755	0.321	-0.215	0.022	0.121	0.761	0.211	0.025
Meats	0.345	-0.632	0.096	-0.016	-0.066	-0.193	0.441	0.435
Aquatic Products	-0.285	0.065	-0.613	*0.007*	0.084	-0.104	0.675	0.379
Dairy Products	-0.045	-0.084	-0.021	-1.098	-0.174	-0.112	0.431	0.411
Fresh Fruits	0.044	-0.051	0.119	-0.049	-0.899	-0.125	0.355	0.347
Others	0.812	-0.073	0.085	0.042	0.049	-0.893	0.098	0.074

Note: Meats include beef, pork and mutton. Aquatic products comprise of all kind of sea foods.
Values in italic identify that estimated elasticity is not significant at 0, 01 level of significance.

Table-4: Unconditional Marshallian Elasticities

Quantities	e_{ij}* (Unconditional Marshallian Elasticities) Prices							
Variables	**Rice**	**Meat Product**	**Aquatic Products**	**Dairy Products**	**Fresh Fruits**	**Others**	**Expenditure Elasticity**	**Income Elasticity**
Rice	-0.614	0.218	-0.175	0.116	0.109	0.518	0.345	0.096
Meats Products	0.426	-0.713	-0.015	0.005	-0.084	-0.254	0.394	0.277
Aquatic Products	-0.175	-0.047	-0.518	0.025	0.051	0.065	0.543	0.405
Dairy Products	*0.029*	*0.014*	*0.006*	-1.001	-0.205	-0.269	0.476	0.463
Fresh Fruits	*0.009*	-0.047	0.087	-0.118	-0.712	-0.205	0.311	0.364
Others	0.501	-0.091	0.197	-0.167	-0.087	-0.912	0.091	0.038

Note: Meats include beef, pork and mutton. Aquatic products comprise of all kind of sea foods.
Values in italic identify that estimated elasticity is not significant at 0, 01 level of significance.

V Conclusion

This study analyses household demand of Heilongjiang, Shandong and Henan provinces in Urban China. For this purpose, 2017 data set is applied which the most recent data was set during the study period. For the analysis, 6 different food groups are chosen to derive the potential demand estimation. These food groups are first rice and aquatic products which are mostly consumed products in Asian countries, such as China, Vietnam or Korea. Also, meats, fresh fruits, dairy, and other products included. Households' disposable income also included for the estimation of income elasticity of the individuals.

All in all, the Rotterdam models are used for estimation by SAS program. There are several studies in the literature using the Rotterdam Model for elasticity estimation (Washington, and Kilmer, 2002; Clements, and Gao, 2015). It leads to calculate Conditional Hicksian elasticity, conditional and unconditional Marshallian elasticity which provide researchers a comparison opportunity. Even if the Rotterdam model results are coherent with the literature, some studies prefer to use Almost Ideal Demand System analysis (AIDS) or Linear Approximate AIDS (LA/AIDS) model. Therefore, for future researches, LA/AIDS model can be applied to compare the study results.

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