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HOUSEHOLD DEMAND IN TURKEY: AN APPLICATION OF ALMOST IDEAL DEMAND SYSTEM WITH SPATIAL COST INDEX

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Abstract

A common difficulty in estimating demand functions for developing countries is the lack of time series data. With the available cross-sectional data resulting from extensive surveys on households, most researchers concentrated on the estimation of expenditure elasticities and ignored the price elasticities. Obviously, the results of this kind of partial analysis may not be very reliable for policy design. In this paper, a practical solution is provided by observing that regularly collected data on the cost of grouped commodity bundles across regions can reflect the spatial variation in prices and thus can be used as a proxy for the prices. As compared to previous studies estimating only the expenditure elasticities for Turkey, our results are different, in some cases with large margins. Thus, as expected, incorporation of prices into the demand analysis is vital not only in obtaining the price elasticities, but also in getting reliable estimates of the expenditure elasticities.

1. Introduction

Estimation of demand for goods and services has attracted the attention of both the theoreticians and empiricists, and a very dense literature is now available. Some of these studies have ignored required connections between the theory and empirical analysis, and concentrated on the estimation of single demand equations. Given the doubts surrounding the results of such an approach, empirical work has been directed towards the estimation of complete demand systems. The Linear Expenditure System (LES) of Stone (1954) has been the pioneer of this literature. Some limitations of LES such as proportional income and price elasticities, and ruling out of the complementary relationship among goods opened doors to the development of other models. Rotterdam model (Theil 1965) and Translog model (Christensen et al. 1975) can be listed among these more flexible models. More recently, Deaton and Muellbauer (1980) have proposed an alternative modeling which they have named as the Almost Ideal Demand System (AIDS). This new modeling has attracted a great deal of attention, and has been used extensively in empirical works. Moreover, extensions of the standard AIDS has been developed to make this modeling as rich as possible. Among these, we can mention inverse AIDS by Moschini and Vissa (1992), quadratic AIDS by Banks et al. (1997), more recently semi-flexible Almost Ideal Demand System by Moschini (1998).

Estimation of demand functions is very useful as they provide us with income and price elasticities. The measurement of income and price elasticities is required for the design of many different policies. For example, intelligent policy design for indirect taxation and subsidies requires knowledge of these elasticities for taxable commodities and services (Deaton, 1988). Such knowledge would normally be obtained by the analysis of time-series data on demand for commodities, prices, and income. Unfortunately, in Turkey, as well as in many developing countries, time-series data is not readily available to estimate demand system for commodities and services. As a result of this data limitation, most researchers opt for simplification of the general models tailored to the availability of the data. With cross-sectional data, customary analysis estimates the Engel curves (the relationship between total commodity expenditure and income) with the incorporation of additional household variables, such as size, and some other demographic variables. Earlier studies on Turkey, by Tansel (1986) and Senesen and Selim (1995) estimated Engel curves from 1979 and 1987 Household Expenditure Survey Data, respectively. The general problem with such approaches is the model misspecification (due to the exclusion of price terms), and thus the estimated results are not so reliable. For example, Polinsky (1977) has shown that failure to specify the model with price effects adequately could result in biased and misleading income elasticities.

Although time series data is not available, many developing countries regularly collect household survey data on expenditures. Thus, the important question that needs to be answered is whether price variation can be obtained from those surveys in order to estimate a complete demand system. Deaton (1988) states that these household surveys contain information on the spatial distribution of prices, and thus, by recovering this information in a useful form one can easily obtain the impact of prices on quantity-demanded. In his paper, he identifies a methodology that achieves this objective. We, in this paper, cannot readily use Deaton's methodology due to the limitations of the survey data in its published form but we suggest a practical solution to this data limitation.

The published form of the Turkish consumption expenditure survey data is aggregated at five income percentiles and nineteen provinces. The State Institute of Statistics (SIS) of Turkey also gives cost of the bundles of the aggregated commodities and services in order to construct price indices for nineteen provinces across the country. This information can be used as a proxy for the prices. Given, for example, different transportation costs, there will be spatial variation in the costs of aggregated commodities and services across the provinces. This variation can be used to obtain the price information, which is missing in the cross-sectional data on households. Thus, a complete demand system can be estimated, and price and income elasticities can be calculated as a result.

Our study updates the earlier demand studies on Turkey on two fronts. First and foremost, we present estimates of price elasticities for 10 different commodity aggregates. None of the previous studies on Turkey estimated price elasticities. Secondly, by incorporating the price variation into the model, the model misspecification problem of the previous studies has been removed, and so we have obtained more reliable estimates of the expenditure elasticities as well. Finally, this is one of the first studies, which applies the Almost Ideal Demand System (AIDS) to estimate the complete demand system for Turkey. As this method is now very widely used and relied upon by most empiricists, we believe that the paper is also valuable regarding this modeling choice. Although our study concentrates on Turkey, it can be applied to many different developing countries, which face similar data limitations on prices.

The organization of this paper is as follows. In section two, the model for the estimation of complete demand system will be presented. In the next section, we will describe the data set and the estimation procedure. The empirical findings will be reported in section four. We will finish with some concluding remarks.

2. Demand System Specification

The Linear Expenditure System (LES) of Stone (1954) with its major attractions such as linearity, transparency, and the parsimony of the estimated parameters, was used by many researchers for quite some time. Its application in a substantial

number of countries as summarized in Lluch et al. (1977) imply that it is probably the dominant model used for the consumer demand in Computable General Equilibrium models of developing countries (see also Clements et al. 1996). Nevertheless, the uneasiness with some of its strong restrictions like the proportionality between price and income elasticities, and necessity goods becoming luxury ones at higher incomes opened road to the development of new models. Rotterdam model of Theil (1965) and Translog model of Christensen et al. (1975) corrected some of these shortcomings but they introduced their own limitations. More recently, Deaton and Muellbauer (1980)suggested an alternative modeling. As their very courageous naming of the model (almost ideal demand system) implies, it may be seen as the most advanced modeling of the complete demand systems. The general model is as follows:

$$W_i = \alpha_i + \sum_j \gamma_{ij} \ln P_j + \beta_i \ln \left[\frac{M}{P} \right] \quad (1)$$

where W_i is the budget share of the i^{th} good, M is the total consumption expenditure, P_j is the price of the jth good, P is a properly defined price aggregator. The AIDS model is based on the consumer's expenditure function and as seen clearly in equation (1), it expresses the budget share of a given commodity as a function of total expenditure and prices. Open form of the price aggregator is given by:

$$\ln P = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln p_i + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij} \ln p_i \ln p_j \quad (2)$$

Where the coefficients are coming from the expenditure function of an individual household. This model gives an arbitrary first-order approximation to any demand system. It satisfies the axioms of choice, and aggregates perfectly without the requirement of the parallel linear Engel curves. It has the features of both the Rotterdam and Translog models. As seen in equation (1), the P term makes AIDS a nonlinear model. However, in the literature, empiricists used a linear approximation for P quite often. The linear approximation most commonly employed (which is known as Stone Price index) is given by:

$$\ln P = \sum_{i=1}^{n} \alpha_i \ln p_i \quad (3)$$

With the following parameter restrictions, equation (1) satisfies the adding-up, homogeneity, and symmetry properties derived from the standard demand theory:

$$\sum_i \alpha_i = 1, \sum_i \beta_i = 0, \sum_j \gamma_{ij} = 0, \sum_i \gamma_{ij} = 0 \text{ and } \gamma_{ij} = \gamma_{ji}. \quad (4)$$

Expenditure and price elasticities then can be derived easily:

$$\eta_i = 1 + (\beta_i / w_i) \quad (5)$$

$$\varepsilon_{ii} = -1 + (\gamma_{ii} / w_i) - \beta_i \quad (6)$$

$$\varepsilon_{ij} = (\gamma_{ii} / w_i) - \beta_i w_j / w_i \quad (7)$$

where η_i is the expenditure elasticity, w_i is the budget share of good i, ε_{ii} is the own price elasticity, and ε_{ij} represents the cross-price elasticity, in Marshallian terms (uncompensated). Compensated (Hicksian) price elasticities, e_{ij}, can be derived easily by using η_i, ε_{ii} and ε_{ij} and the following relation:

$$e_{ij} = \varepsilon_{ij} + \eta_i * w_j \quad (8)$$

To be able to get these elasticity estimates, we need to have time series data on prices. In most of the developing countries, time series data is not available. Nevertheless, most of the time household survey data is regularly collected. Can we make use of this survey data to overcome the time series limitation? Deaton (1988) answers this in the affirmative and proposes to use the spatial variation in prices which can be obtained from survey data. In his approach, unit values are calculated by using total expenditure on a certain commodity and quantity consumed. By removing quality effect and error of measurement from the unit values, a proxy for the missing time series price variable can be constructed. However, Deaton's (1988) approach requires the availability of data at the household level and such data may not be made available to the researchers by the institute carrying out the household surveys, as in the case of Turkey. We propose a practical solution (only for the aggregated goods and services) below for cases where Deaton's methodology may not be used.

In Turkey and in many other developing countries, data on the cost of the bundles of the aggregated goods and services are collected from different regions regularly for the calculation of regional price and standard of living indices. Due to, for example, transportation costs[1], these cost figures differ regionally and we suggest that they reflect the spatial variation in prices for the aggregated goods and services similar to the spatial variation in the prices of the individual goods and services described in Deaton (1988). By using these cost figures of aggregated commodities as a proxy for prices, we can calculate the price elasticities at the aggregate level (but not for individual commodities). It is assumed that costs of commodity aggregates are the same within a city (the regional unit in the case of Turkey). Available data shows that there is a large variation across cities. Given the lack of any price elasticity information calculated empirically for Turkey as well as many other developing countries, we

[1] Additional variables are listed by Prais and Houthakker (1955): price variations across regions may be due to price discrimination, services bundled with the commodity, seasonal effects, and quality differences caused by the heterogeneous commodity aggregate.

think that this is a worthwhile attempt. We believe that our approach can be used in many developing countries in which price elasticity can not be calculated due to data limitations.

3. Data and Estimation

Data for this study is obtained from the 1994 Household Consumption Expenditure Survey Results of the State Institute of Statistics (SIS) of Turkey. SIS provided an electronic copy of the Household Consumption Expenditure Survey Results for 19 Selected Province Centers aggregated into five income percentiles. The cost indices of the bundles of the aggregated commodities and services for 19 Selected Province Centers are also obtained from the SIS. The expenditure data are pooled across the 19 provinces and five income percentiles in each province in the study. We assumed that cost indices of the bundles of the commodities and services are only different across the provinces, but not within the province. In other words, we assumed that households at different income percentiles have the same cost indices for the aggregated commodities and services within the same province. Our study includes the following ten commodity aggregates: food (F), clothing (C), education (ED), entertainment (EN), furnishing (FR), health (H), housing (HO), tourism (T), transportation (TR) and others (OT). The prices for these commodity aggregates are based on the cost of these commodity aggregates in each province. Table I presents descriptive statistics related to our data set.

A system of share equations based on equation (1) and subject to the restrictions (adding-up, homogeneity, and symmetry) in (4) is estimated using Iterative Seemingly Unrelated Regression (ISUR) method of Zellner. This method is equivalent to full Information Maximum Likelihood (FIML) estimation. The adding-up property of demand causes the error covariance matrix of system to be singular, so one of the expenditure share equations is dropped from the system to avoid singularity problems. The estimates are invariant of which equation is deleted from the system. Homogeneity is maintained by normalizing all of the prices (based on the aggregate cost figures) by the price of others group (OT). The coefficients pertaining to the expenditure share equation of others aggregate (OT), which is dropped from the system in the estimation stage, are obtained by using the adding-up property. Symmetry is imposed during the estimation of the system of equations. The AIDS model in equation (1) is modified by the inclusion of some household variables such as household size and dependency rate. For each equation, we have 95 observations, so a total of 855 observations are used for the estimation of the coefficients. Now, we present the results of our estimation.

4. Results

The estimated parameters of the AIDS model in equation (1) are given in Table 2. The dependent variables are the expenditure share of each commodity aggregate. Independent variables are the logarithm of total expenditure deflated by the Stone price aggregator (lnE), logarithm of household size (lnS), logarithm of dependency rate (lnDR), and relative prices of commodity aggregates with respect to others aggregate (lnF for food, lnC for clothing, lnHO for housing, lnFR for furnishing, lnH for health, lnTR for transportation, lnEN for entertainment, lnED for education, lnT for tourism). It can be seen from the estimated results that coefficients of most of the explanatory variables are significant at the 1 or 5 percent significance level. In Tables 3 through 5, uncompensated, compensated price elasticities and expenditure elasticities, respectively, are presented (calculations are made at the sample means). Expenditure and own-price elasticities are of expected sign. Only food and health services fall into necessity group (expenditure elasticities are 0.56 and 0.87, respectively). All others have expenditure elasticity larger than 1. The largest expenditure elasticity is 1.94 for both the education and transportation services. Except for health, education, tourism services, and possibly clothing all commodity aggregates are in the inelastic region of their demand curves at the sample mean. Commodity aggregates have mostly positive cross-price elasticities, and so they are most of the time substitutes for each other. Education is in a complementary type relationship with all aggregated commodities except food, health, entertainment and housing. Food aggregate is in a complementary type relationship only with transportation and tourism aggregates.

The impact of household size on food and housing expenditures is surprisingly negative, that is, larger size families have lower food and housing expenditures. This may be due to the shift from the higher quality to the lower quality items under the tight budget constraints of the larger size families. In the case of food, larger size households perhaps prefer inexpensive food not only due to budget constraints, but also due to time constraint; that is to say, it takes quite some time to cook food for a large size family, and so, food patterns for these families may tilt towards easy-to-prepare items such as macaroni, rice and etc., which are relatively inexpensive.

Our results show that the estimated expenditure elasticities differ from the findings of earlier empirical works on Turkey by Tansel (1986), and Senesen and Selim (1995). In some cases, there are large variations in magnitudes. For example, in both of these studies, health services are found to be a luxury good whereas our study finds health services as a necessity. As compared to Tansel's results, furnishing aggregate shows a reversal from necessity to luxury; others are somewhat in a comparable range. If compared to findings of Senesen and Selim (1995), housing aggregate shows a sharp contrast (luxury in their case and necessity in ours), and expenditure elasticity of transportation aggregate is quite different in magnitude.

5. Conclusions

A common difficulty in estimating demand functions for the developing countries is the lack of time series data. With the available cross-sectional data resulting from extensive surveys on households, most researchers concentrated on the estimation of expenditure elasticities and ignored the price elasticities. Obviously, the results of this kind of partial analysis may not be very reliable for policy design. Deaton (1988) introduced a methodology for using household survey data to estimate the price elasticities by making use of spatial variation in prices. However, its application requires certain conditions on the data, which may not always be met, as in the case of Turkey. In this paper we introduced a practical solution by using spatial variation in the cost of aggregated commodity bundles across the selected regions as a proxy for their prices. This approach can easily be applied in all developing countries that collect cross-sectional data from households but do not have adequate time series data. Then, we estimated a complete demand system for Turkey by using this alternative approach.

This study is distinguished from other similar studies done earlier with respect to several important considerations. None of the previous studies presented price elasticities. This was not so surprising due to the unavailability of the time series price data for Turkey. As compared to previous studies estimating only the expenditure elasticities for Turkey, our results are different, in some cases with large margins. Thus, as expected, the incorporation of prices into the demand analysis is vital not only in getting the price elasticities but also in obtaining the reliable estimates of the expenditure elasticities. Until getting an adequate time series data on prices, our estimates on price elasticities should be very useful in the evaluation of many different government policies.

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Table 1: Descriptive Statistics

Per Capita Expenditure of (Turkish Liras / Month)	Average	Standard Deviation	Minimum	Maximum
Food (F)	753.6	178.2	376.9	1327.0
Clothing and Foot Wear (C)	221.4	131.6	33.2	580.4
Housing and Rent (HO)	559.1	289.5	183.5	2222.5
Furnishing (FR)	208.5	163.6	15.3	998.0
Health (H)	53.5	38.4	9.0	211.8
Transportation (TR)	208.5	247.2	5.5	1575.2
Entertainment and Culture (EN)	57.2	55.5	2.4	349.5
Education (ED)	42.0	56.2	2.2	334.8
Tourism (T)	66.4	59.7	9.8	446.4
Others (OT)	140.3	106.1	14.7	603.3
Per Capita Total Expenditure	2330.6	1196.5	672.9	7759.0
Cost of F Aggregate	28.0	2.0	24.2	32.1
Cost of C Aggregate	305.9	129.8	62.2	504.8
Cost of HO Aggregate	702.7	284.7	336.0	1546.3
Cost of FR Aggregate	6409.9	1170.6	4379.6	9021.7
Cost of H Aggregate	195.5	59.7	114.5	319.0
Cost of TR Aggregate	80055.0	3246.3	74583.0	86046.0
Cost of EN Aggregate	3514.1	531.4	2698.9	4731.2
Cost of ED Aggregate	398.2	233.3	141.5	905.4
Cost of T Aggregate	27.0	14.2	15.3	65.1
Cost of OT Aggregate	544.2	46.2	464.7	660.2
Household Size	4.41	0.676	2.74	6.63
Age Distribution (%)				
0-4	0.093	0.033	0.050	0.296
0-12	0.183	0.032	0.100	0.259
0-17	0.126	0.024	0.071	0.174
18 and +	0.598	0.055	0.545	0.723

Table 2: Parameter Estimates of Demand System (AIDS Model)

Constant	Dependent Variable: Expenditure Share of									
	F	**C**	**HO**	**FR**	**H**	**TR**	**EN**	**ED**	**T**	**OT**
	0.384	-0.086	0.460	-0.163	-0.056	-0.182	0.084	0.15	-0.74	1.0370
	(1.26)	**(-2.32)**	**(6.51)**	(-1.07)	(-0.74)	(-0.41)	(0.87)	**(2.82)**	(-1.38)	
LnE	-0.161	-0.018	-0.032	-0.053	0.006	0.068	0.015	0.014	0.003	-0.1580
	(-17.82)	**(-2.75)**	**(-2.66)**	**(5.16)**	(-1.55)	**(4.24)**	**(3.77)**	**(3.03)**	**(1.81)**	
LnF	0.046	-0.013	-0.006	-0.029	-0.006	-0.039	0.002	0.017	-0.019	-0.0470
	(1.19)	**(-3.85)**	(-0.89)	***(-1.68)***	(-0.64)	(-0.82)	(0.19)	**(2.70)**	**(-3.27)**	
LnC	-0.013	0.003	-0.007	0.004	-0.002	0.011	0.001	-0.003	0.004	-0.0002
	(-3.85)	*(1.50)*	**(-2.56)**	(1.10)	(-1.33)	***(1.95)***	(0.67)	**(-1.94)**	**(3.92)**	
LnHO	-0.006	-0.007	0.056	-0.014	-0.003	-0.009	-0.004	-0.008	0.007	0.0120
	(-0.89)	**(-2.56)**	(7.25)	**(-2.09)**	(-1.29)	(-0.83)	(-1.29)	**(-3.00)**	**(3.59)**	
LnFR	-0.029	0.004	-0.014	0.017	-0.002	0.028	-0.002	-0.002	-0.003	-0.0003
	(-1.68)	(1.10)	**(-2.09)**	(0.95)	(-0.37)	(1.05)	(-0.22)	(-0.39)	(-0.73)	
LnH	-0.006	-0.002	-0.003	-0.002	-0.008	0.009	0.001	0.009	-0.006	-0.0008
	(-0.64)	(-1.33)	(-1.29)	(-0.37)	***(-1.82)***	(0.75)	(0.28)	**(3.42)**	**(-2.96)**	
LnTR	-0.038	0.011	-0.009	0.028	0.009	0.059	-0.010	-0.013	0.012	0.0490
	(-0.82)	**(1.95)**	(-0.83)	(1.05)	(0.75)	(0.73)	(-0.58)	(-1.45)	(1.41)	
LnEN	0.002	0.001	-0.004	-0.002	0.001	-0.010	0.013	0.003	0.001	0.0170
	(0.19)	(0.67)	(-1.29)	(-0.22)	(0.28)	(-0.58)	**(2.04)**	(1.18)	(0.22)	
LnED	0.017	-0.003	-0.008	-0.002	0.009	-0.013	0.003	-0.003	0.003	-0.0030
	(2.70)	**(-1.94)**	**(-3.00)**	(-0.39)	**(3.42)**	(-1.45)	(1.18)	(-1.18)	**(1.73)**	
LnT	-0.019	0.004	0.007	-0.003	-0.006	0.012	0.001	0.003	-0.002	-0.0030
	(-3.27)	**(3.92)**	**(3.59)**	(-0.73)	**(-2.96)**	(1.41)	(0.22)	**(1.73)**	(-0.89)	
Ln(S)	-0.057	0.096	-0.149	0.038	0.004	0.010	0.004	0.015	0.013	-0.0260
	(-2.45)	**(6.13)**	**(-5.21)**	(1.48)	(0.41)	(0.25)	(0.36)	(1.33)	**(1.70)**	
Ln(DR)	-0.099	-0.015	-0.015	-0.009	0.021	0.044	0.001	0.007	0.033	-0.0320
	(-4.46)	(0.91)	(-0.50)	(-0.38)	**(2.27)**	(1.11)	(-0.08)	(0.66)	**(4.27)**	

Notes: t values are provided in the parenthesis; bold and bold italics indicate that parameters are significant at the 1 or 5 percent significant levels, respectively.

Table 3: Marshallian Price Elasticities

	F	C	HO	FR	H	TR	EN	ED	T	OT
F	**-0.71**	0.00	0.09	-0.04	-0.01	-0.07	0.02	0.05	-0.04	0.15
C	-0.21	**-0.98**	-0.12	0.02	-0.02	0.10	0.01	-0.03	0.04	0.01
HO	0.02	-0.02	**-0.74**	-0.04	-0.01	-0.03	-0.01	-0.03	0.03	-0.04
FR	-0.59	-0.01	-0.32	**-0.84**	-0.04	0.30	-0.03	-0.04	-0.06	-0.01
H	-0.14	-0.03	-0.06	-0.05	**-1.33**	0.46	-0.14	0.42	-0.24	0.37
TR	-0.87	0.06	-0.35	0.31	0.11	**-0.25**	-0.16	-0.20	0.15	-0.73
EN	-0.16	-0.02	-0.34	-0.12	0.03	-0.54	**-0.39**	0.13	0.01	-0.30
ED	0.79	-0.27	-0.79	-0.21	0.59	-0.96	0.19	**-1.24**	0.17	-0.19
T	-0.76	0.15	0.26	-0.14	-0.24	0.47	0.02	0.11	**-1.07**	0.10
OT	0.63	-0.02	-0.36	-0.00	0.12	-0.93	-0.11	-0.04	0.03	**-0.84**

Notes: Food (F), clothing (C), education (ED), entertainment (EN), furnishing (FR), health (H), housing (HO), tourism (T), transportation (TR) and others (OT).

Table 4: Hicksian Price Elasticities

	F	C	HO	FR	H	TR	EN	ED	T	OT
F	**-0.51**	0.06	0.23	0.00	0.01	-0.03	0.03	0.06	-0.03	0.18
C	0.23	**-0.87**	0.17	0.12	0.00	0.19	0.03	-0.01	0.07	0.07
HO	0.34	0.06	**-0.53**	0.03	0.01	0.04	0.01	-0.02	0.06	0.00
FR	0.01	0.14	0.08	**-0.71**	-0.00	0.42	0.00	-0.01	-0.01	0.08
H	0.11	0.02	0.10	-0.01	**-1.33**	0.49	0.07	0.41	-0.25	0.39
TR	-0.17	0.24	0.13	0.47	0.15	**-0.11**	-0.12	-0.17	0.20	-0.62
EN	0.46	0.14	0.08	0.01	0.07	-0.41	**-0.35**	0.16	0.05	-0.21
ED	1.49	-0.10	-0.31	-0.05	0.63	-0.82	0.23	**-1.21**	0.22	-0.08
T	-0.36	0.26	0.53	-0.05	-0.21	0.55	0.04	0.13	**-1.05**	0.16
OT	1.18	0.12	0.01	0.12	0.16	-0.82	-0.08	-0.02	0.07	**-0.76**

Table 5: Marshallian Own-Price and Expenditure Elasticities

	AIDS Model	
	Own-price	**Expenditure**
F	-0.71	0.56
C	-0.98	1.20
HO	-0.74	0.87
FR	-0.84	1.64
H	-1.34	0.74
TR	-0.25	1.94
EN	-0.40	1.70
ED	-1.24	1.94
T	-1.07	1.10
OT	-0.84	1.52