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Separability between own food production and consumption in Turkey

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Abstract Complete markets imply the separation of food production and consumption decisions such that they can be modeled to occur sequentially and can be studied independently. Separation is very often assumed implicitly in empirical studies of food demand. If there is such separation, then food sourced within the household should not have any influence upon the budget share of each food group. Using this insight, this paper first develops a procedure to test for the separation of household food production and consumption decisions. Furthermore, it incorporates the testing procedure into the Almost Ideal Demand Systems model and utilizes survey data from 2003 for Turkey for empirical testing. It concludes that the separation assumption is unwarranted for Turkey. Next, it investigates the extent of bias in elasticity estimates when the separation assumption is unwarranted. It concludes that ignoring the nonseparation of consumption and production decisions in rural areas leads to significant overestimation of food expenditure elasticity for dairy products and eggs and own-price elasticity for bread and cereals.

Keywords Agricultural household models · Own-produced food consumption · Turkey · Elasticity estimates · Dairy products

JEL Classification Q12 · D12 · D13

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1 Introduction

Estimating price and income elasticities of food demand has been a central concern in consumer economics. Demand systems most widely used for estimating food demand are originally developed for industrialized countries, and are reasonably based on the assumption that price and income are exogenous to food demand. However, these assumptions proved to be unrealistic for the case of low-income countries where peasant households are typically both producers and consumers of food items. Hence, agricultural household models (AHM) have been developed by agricultural economists, beginning in late 1970s, to deal with the endogeneity of household budget to food production and consumption, and to gain insights about the behavior of producer–consumer rural households. The initial goal of this line of scholarship was to develop an understanding of these households' production and consumption responses to agricultural price policy, since policy makers in developing countries with large peasant populations had been frustrated with the peasantry's apparent unresponsiveness to price incentives or opportunities to modernize (de Janvry et al. 1991). Since then, the AHM models have been extended to tackle a number of issues, ranging from deforestation to migration (Taylor and Adelman (2003) present an excellent review of the literature).

Nevertheless, demand system equations that have been initially developed for industrialized countries are still being regularly used for estimating food demand in middle income countries like Turkey. This strategy is somewhat valid, as these countries might have majority urban populations who are price takers as consumers of food. But middle income countries typically host substantial peasant sectors as well. Hence, I question the indiscriminate application of the above-mentioned models in the analyses of middle income countries. More specifically, I aim to contribute to the existing literature by first developing a formal procedure to test if households are mere price takers, and then to test if estimated price and expenditure elasticities differ significantly after food consumption from home produce (self-produced food hereafter) is taken into account. To my knowledge, this study is the first of its kind, as it incorporates AHM's insights to the analysis of country-level data sets in estimating price and expenditure elasticities.

In this paper the empirical focus is on Turkey as an example of middle income country with a majority of urban populations combined with significant proportions of self-produced food in rural areas [among EU member states, Bulgaria and Romania, similar to Turkey, also have substantial semi-subsistence farmers (Davidova et al. 2009)]. Recent household food consumption and food demand studies pertaining to Turkey (Akbay et al. 2007; Sengul and Tuncer 2005) implicitly assume that households behave as mere price takers in food consumption. Using the 2003 household budget survey data for Turkey, however, I demonstrate that self-produced food accounts for almost 19% of the calorie intake for rural households (Sect. 4). This finding suggests that own-production is a significant source of food supply for rural households in Turkey and hence should not be assumed away.

Against this backdrop, I test if the share of self-produced food in total food budget affects food consumption decisions of rural households in Turkey. I find that it does, and thus conclude that the implicit assumption of separate food consumption and production decisions is untenable in the case of Turkey. Consequently, I argue that the aforementioned studies of price and expenditure elasticities, which do not take food production's effect on consumption into account, are mis-specified. I then re-estimate price and expenditure elasticities by utilizing a model that incorporates the share of self-produced food as well as interaction terms of self-produced food with food expenditure and prices. I find, in particular, that food expenditure (for dairy products and eggs) and price (for bread and cereals) elasticities for rural households in Turkey are significantly over-estimated when consumption from home produce is ignored. Given that dairy, egg and cereals are the items most heavily self-produced, my results resonate with the previous theoretical work and simulation exercises of de Janvry et al. (1991) and Taylor and Adelman (2003), which predict that models assuming rural households as price takers will over-estimate income and price elasticities.

In the rest of the paper, I first review the literature on AHM, with particular attention to separable and nonseparable household models. Next, I develop a procedure to test for the implicit assumption of separation, since constructing a proper AHM is not possible with the dataset I employ. I then re-estimate price and food expenditure elasticities by accounting for self-produced food consumption by the majority of rural households. In Sect. 3, I flesh out the empirical model used for estimation. Section 4 presents data on food consumption with a special emphasis on self-produced food. Section 5 presents the econometric findings. Section 6 concludes the paper.

2 Theoretical framework and hypothesis testing strategy

2.1 Agricultural household models

An agricultural household typically engages in agricultural production while being a site of food consumption as well. Very often the major inputs of production—land and labor—are supplied by the household. In the absence of transaction costs, which lead to imperfect functioning of markets, it can be assumed that production and consumption decisions are made sequentially (Sadoulet and de Janvry 1995). This assumption does not necessarily mean that production and consumption decisions are always sequential; all it implies is that production and consumption decisions can be studied separately.

Yet, in practice, incomplete markets are generally the rule rather than the exception in the context of rural areas in developing countries. Here, I adopt the definition formulated by Sadoulet and de Janvry (1995), who state "a market may fail for a particular household when it faces wide price margins between the low price at which it could sell a commodity or the factor and the high price at which it could buy that product or factor" (p. 149). The most common reasons accounting for market incompleteness are (1) transaction costs due to poor infrastructure, high marketing costs due to merchants' local monopoly power, and supervision costs of hired labor; (2) shallow local markets brought by high covariation between household supply and output prices; (3) price risks and risk aversion of farmers resulting in risk hedging by discounting of sales prices and upward revision of purchase prices; and (4) limited access to working capital, implying binding budget constraints and leading to seeking self-sufficiency, as actions that require cash outlays (e.g. hiring outside labor or using fertilizer) carry the cost of financing, while cash-generating activities, even if seemingly unprofitable (e.g. selling milk), are pursued to ease the cash constraint, especially in the lean season.

Under market imperfections, exogenous market prices no longer accurately reflect the full opportunity cost of goods and services. In particular, some goods become nontradeable in the presence of imperfect markets (Sadoulet and de Janvry 1995: 149–150) and their prices are determined internally by the household. Thus, the households' production and consumption decisions are no longer separate, but rather are jointly made. Taylor and Adelman (2003) summarize this issue as follows: "In general, a market is missing if the cost of participating (transaction costs) are so high that self-sufficiency is the household's optimal strategy. Transaction costs subtract from the sales price of producers while adding up to the purchase price of consumers" (pp. 42–43).

The fact that consumption and production decisions are often nonseparable has direct implications for policy analysis. Both de Janvry et al. (1991) and Taylor and Adelman (2003) demonstrate that the impact of market price changes on food consumption and production decisions are strongest (i.e. magnitudes of elasticities are largest) when a market functions properly. If, on the other hand, markets for food and/or labor are incomplete the impact of price changes is muted. In other words, price elasticity of food is lower when markets are incomplete. Furthermore, Taylor and Adelman (2003) show that when the household is labor-abundant and the market for labor is missing, which is arguably the most commonly observed feature of developing countries, family labor would be trapped on the farm. The absence of the labor market depresses the 'shadow wage' and stimulates consumption from own-produce.

The data on rural households in Turkey suggest that self-produced food is significant, supplying almost 19% of calories consumed by rural households. This empirical finding, coupled with the existing literature on AHM, suggests that different models should be specified for the behavior of rural households (following the AHM approach) and that of urban households (primarily price takers) in Turkey. However, empirical operationalization of the full AHM is complex and even its simplest application requires substantial data, especially when dealing with a nationally representative data set. The data set employed in this paper does not provide sufficient information especially on the productive factors to allow constructing the production-side of AHM.[1] Therefore, I follow the second-best approach, where I include an additional variable in the 'standard' demand system to test for the significance of self-produced food. Even though I cannot construct a proper AHM in the theoretical sense, I utilize this variable and re-estimate price and income elasticities of food by including interaction terms of prices and food expenditure with the share of self-produced food.

[1] There is no data on any factors other than value of land owned and total hours worked. Especially there is no data on the allocation of productive factors among competing uses.

2.2 Test of separability

Studying the rural labor markets in Java, Benjamin (1992) uses household demographic attributes to identify nonseparation: "… identification of nonseparation relies on the observation of a correlation between demographic composition and observed farm employment" (p. 292). If the household exhibits Chayanovian characteristics—that is, if all or most of the labor is sourced within the family—then total labor expended in agricultural production depends on household characteristics such as household size and the number of working age adults. However, if there is an active labor market then family size is not a binding constraint and laborers can be hired as needed.[2] To test this theory empirically, Benjamin (1992) estimates the impact of demographic variables on labor demand after taking into account prevailing market wage, area harvested, inputs used, and controls for soil and climate conditions.[3]

I develop a similar procedure by utilizing the budget share of self-produced food to identify nonseparation. In doing so, I build on a reasoning akin to that of Hoddinott and Haddad (1995), who observe that if household members pool their income and spend it to maximize joint household utility, then who controls income within the household should not matter for household consumption decisions. As a test of this implication of the unitary household model, they estimate the determinants of household spending on different items such as food, clothing, etc., where they include the wives' share of cash income as an explanatory variable in addition to total household expenditure and a number of demographic characteristics. The authors find that female independent income—a proxy of intra-household bargaining power—, has a positive and significant impact on household spending on food and children's needs.

For the case of rural Turkey, I hypothesize that if the households' consumption and production decisions are separable, then the budget share of self-produced food should not affect the composition of food basket. Put in terms of empirical testing, the coefficient estimate for the budget share of self-produced food should not be statistically significant. In the case of separable decisions, observed self-produced food is merely the household treating itself as another supermarket. However, if the production and consumption decisions are nonseparable, then the coefficient estimate for the budget share of self-produced food would be significant. In addition, I specify interaction terms of self-produced food budget shares with prices and food expenditure to be able to test alternative specifications, and to re-estimate elasticities. Including interaction terms thus allows me to see whether price and expenditure elasticities of the 'standard' model are misspecified.

[2] Alternatively family members are not limited by size of agricultural holding for employment and can find employment for excess labor.

[3] He finds that they are not statistically significant in rural Java; i.e., the labor market functions well in rural Java.

3 Empirical models

Studies which use micro household data for analyzing food demand in Turkey are fairly rare. Recent examples are Sengul and Tuncer (2005), Akbay et al. (2007), and Armagan and Akbay (2008). The first two of these works use data sets compiled by the State Institute of Statistics (SIS): Sengul and Tuncer (2005) use the 1994 Household Budget Survey (SIS 1994) and Akbay et al. (2007) use data from the 2003 survey (SIS 2003). I also use the SIS (2003) data set. Unlike SIS (1994), the SIS (2003) data set presents the opportunity to identify the source of food consumption: purchased at the market versus self-produced. Both Sengul and Tuncer (2005) and Akbay et al. (2007) use linear two-step estimating procedures, in which they deal with censored data[4] issues in the first step. After taking care of censored data issues, both papers employ the linear approximation (LA) of the almost ideal demand system (AIDS) in the second step, i.e. LA/AIDS, developed by Deaton and Muellbauer (1980). I utilize the same data set as Akbay et al. (2007), and follow their strategy in estimating the benchmark demand system.[5] The rest of this section explains the empirical methodology in detail.

3.1 Linearly approximated almost ideal demand system (LA/AIDS)

Deaton and Muellbauer (1980) introduce the workhorse model for estimating demand systems:

$$w_i = \alpha_i + \sum_{j=1}^{11} \gamma_{ij} \log p_j + \beta_i \log\left(\frac{x}{P^*}\right) + \sum_{j=1}^{25} \lambda_{ij} D_j + e_i \tag{1}$$

I add self-produced food budget share to test the separation assumption (Eq. 2) and interaction terms of self-produced food budget share with prices and food expenditure to re-estimate own-price and expenditure elasticities (Eq. 3). Including self-produced food budget share as an explanatory variable to test for separability is a rather blunt instrument since it imposes the assumption of the identical effect of self-produced food across all households and does not allow for interaction effects. I believe interacting self-produced food budget share with own-price and food expenditure, and including both own-price and interaction variables as controls is a better test of whether self-produced food affects the own-price (and food

[4] Many households do not purchase various food items during the survey month. This can be either due to budget constraint or preferences or consumption from stocks. In other words, the survey observations are censored due to the existence of stocks. Distinguishing between the households who cannot afford such food items from the ones who simply consume from purchases made prior to survey month is important. For example, in the SIS (2003) data set, one-third of households do not have any purchase in the "other food" category—which includes prepared meals, salt, spices, etc.

[5] There are more flexible non-linear functional forms for demand analysis are available (i.e.: QAIDS by Banks et al. 1997). However, the main purpose of this paper is to test for the separation of food production and consumption decisions and to look for evidence of mis-specified elasticities. Hence I prefer to follow the functional forms of existing studies so that my estimates would be comparable to previous studies.

expenditure) elasticity of demand.[6] This is because self-produced food budget share is likely to be zero or insignificant for a large proportion of the households, and in the absence of interaction variables the estimates might not be significant even if they are in fact very important for certain households.

$$w_i = \alpha_i + \sum_{j=1}^{11} \gamma_{ij} \log p_j + \beta_i \log\left(\frac{x}{P^*}\right) + \sum_{j=1}^{25} \lambda_{ij} D_j + \rho_i S + e_i \tag{2}$$

$$w_i = \alpha_i + \sum_{j=1}^{11} \gamma_{ij} \log p_j + \beta_i \log\left(\frac{x}{P^*}\right) + \sum_{j=1}^{25} \lambda_{ij} D_j + \rho_i S + \sum_{j=1}^{11} \delta_i S * \log p_j + v_i S * \log\left(\frac{x}{P^*}\right) + e_i \tag{3}$$

where w_i denotes the budget share of food group i, p_j represents the price of the jth food group, x is the total expenditures on food, α_i, γ_{ij}, β_i, λ_{ij}, δ_i, v_i and ρ_i are parameters to be estimated, P^* is the price index approximated by Stone's index, and e_i is the disturbance term. Dj are demographic variables, including household size, a dummy variable indicating households with young children (younger than 14), controls for age, education, marital status and gender of household heads; employment status of housewives; and seasonal and regional controls.[7] S is the budget share of self-produced food for each household, $S * \log p_j$ is the interaction term of prices and self-produced food budget share, and finally $S * \log\left(\frac{x}{P^*}\right)$ is the interaction term of food expenditure and self-produced food budget share.

3.2 Estimating a complete demand system with censored variable problems

Estimating demand systems in which there are no purchases of certain goods for a large number of observations[8] would yield biased and inconsistent estimates of demand parameters since many dependent variables are valued at zero. One way to deal with latent (unobserved) variables of this nature is to employ a two stage-procedure. Accordingly, a probit model is used in the first stage to determine the probability of the consumption of the good in question for a given household. In the second stage, the independent variables are transformed using information from the initial probit model. Here, I follow the two-step methodology developed by Shonkwiler and Yen (1999) as Akbay et al. (2007, 2008) do.

[6] I am grateful to the anonymous referee for suggesting this extension.

[7] Pollak and Wales (1981) test the alternative methods and conclude that using dummy variables to account for demographic variables (translating approach) fares better among alternatives.

[8] Table 2 shows that for this sample zero purchases are clustered in non-perishable food groups: other food group (33%), non-alcoholic beverage (28%), tea and coffee (24%), and vegetable oils (17%). The survey period is 1 month and it is very possible that many households continued to consume previously purchased goods from storage, like vegetable oils or tea, hence they did not make any purchases during the survey month.

In the first step, the decision to consume specific goods is modeled as a dichotomous choice problem (Heien and Wessells 1990) with a linear probit model (Eq. 4):

$$w_i^* = f(x_i, \mu_i) + u_i, \quad w_i = d_i w_i^*$$
$$d_i = \begin{Bmatrix} 1 & \text{if} & d^* > 0 \\ 0 & \text{if} & d^* \leq 0 \end{Bmatrix} \quad d_i^* = z_i^{'}\theta_i + v_i \tag{4}$$

where i denotes different food groups, w_i and d_i are the observed dependent variables, and w_i^* and d_i^* are the corresponding latent variables. Following Akbay et al. (2007), z_i are vectors of socio-economic and demographic factors such as age, education, gender and marital status of the household head, and household size.

Assuming that the error terms (u_i and v_i) are distributed as bivariate normal with cov (u_i, v_i) = ϕ for each i, Shonkwiler and Yen (1999) correct for inconsistency in estimates by defining the second-stage regression as follows:

$$w_i = \Phi(z_i^{'}\theta_i) f(x_i, \mu_i) + \delta_i \phi(z_i^{'}\theta_i) + e_i \tag{5}$$

where $\phi()$ is the univariate standard normal probability density function (PDF) and $\Phi()$ is the cumulative distribution function calculated by inserting $\hat{\theta}_i$ in place of θ_i which are obtained using Eq. 4 in the first step and e_i is the error term. Shonkwiler and Yen (1999) propose estimating the demand system in the second stage by using either Maximum Likelihood (ML) or Seemingly Unrelated Regression (SUR).[9]

Although the LA/AIDS is the workhorse model of estimating demand systems, the issue of how to deal with censored variables does not seem to be settled. In a commentary on Akbay et al. (2007), Drichoutis, et al. (2008) point out that the error terms are heteroskedastic, and therefore the second stage SUR estimator will be inefficient (p. 95). They suggest using Feasible Generalized Least Squares (FGLS), instead of currently popular ML or SUR procedures, after Tauchmann (2005).[10]

Demand theory requires the imposition of the following three constraints (namely, adding-up, symmetry and homogeneity) on the parameters of Eq. 5:

$$\begin{aligned} &\text{Adding up: } \sum_i \alpha_i = 1, \quad \sum_i \gamma_{ij} = \sum_i \beta_i = \sum_i \lambda_{ij} = \sum_i \delta_i = 0, \\ &\text{Symmetry: } \gamma_{ij} = \gamma_{ji}, \\ &\text{Homogeneity: } \sum_j \gamma_{ij} = 0 \end{aligned} \tag{6}$$

Marshallian own and cross-price elasticities and food expenditure elasticities are computed from the parameters of the LA/AIDS for the variables at sample means (Yen et al. 2002):

9 Akbay et al. (2007) employ iterated SUR.

10 In their response to Drichoutis et al. (2008), Akbay et al. (2008) recalculate the own-price elasticities and food expenditure elasticities for whole sample with coefficient estimates obtained from the FGLS procedure in the second step. In this paper, I also employ the FGLS approach for the second-stage estimation. I use the 3SLS procedure in the STATA package to perform FGLS.

Own-price: $\varepsilon_{ii} = \frac{(\gamma_{ii} - \beta_i w_i^0)\Phi(z_i^{'}\theta_i)}{w_i^0} - 1,$

Own-price including interaction terms: $\varepsilon_{ii} = -1 + \left(\frac{\gamma_{ii}}{w_i^0} - \beta_i - \delta_i S_i^0 + \frac{v_i S_i^0}{w_i^0}\right)\Phi(z_i^{'}\theta_i)$

Food expenditure: $\varepsilon_i = 1 + \frac{\beta_i \Phi(z_i^{'}\theta_i)}{w_i^0}$

Food expenditure including interaction term: $\varepsilon_i = 1 + \left(\frac{\beta_i + v_i S_i^0}{w_i^0}\right)\Phi(z_i^{'}\theta_i)$ (7)

4 Self-produced food

For the first time in 2003, Turkey Household Budget Survey (SIS 2003) collected data that allows distinguishing among sources of food consumption by the household. The SIS (2003) data set classifies food available to households as shown in Table 1. Self-produced food accounts for 7% of total available food in Turkey as a whole, and roughly 19% of rural consumption, calculated in terms of calories.

Food produced and consumed within the household obviously has no market price. In tackling the case of self-produced and consumed food, SIS researchers assigned regional wholesale prices to calculate expenditures on each food category.[11] Due to imputing wholesale prices, as opposed to retail prices, to monetize all consumption, self-produced food accounts for a lower share of total food spending than its share in total calorie supply. Although I have considered imputing regional retail prices of substitute food products instead of regional wholesale prices, this strategy proved to be easier said than done. SIS (2003) includes a list of almost 300 food items, where households report consuming 66 different items on average. To start with, imputing average regional retail prices of so many items is a very arduous process. More importantly, the prevalence of self-produced food is not evenly distributed among regions or food items. Rather, it is concentrated in certain commodities (especially dairy, leafy greens and certain cereals) and regions (Western and Eastern Black Sea, North east, and South east). In practice, this implies that for regions and food items for which self-produced food is especially significant, e.g. fluid milk in the Eastern Black sea region, there are too few observations of retail prices to obtain reliable estimates. Finally, the smallest unit of region in the survey covers several provinces hence average retail prices that can be obtained from the survey data may not be relevant reference price for the rural households who rely on self-produced food.

[11] I verified with SIS officials that wholesale prices are imputed for self-produced food. The imputed wholesale prices are determined according to either the declaration of interviewed households or best guess estimates of interviewers [private correspondence with Sarica, household statistics team leader, (February 2010)]. Key et al. (2000) make the case that for the household as a producer, the shadow price is higher than the market price minus transactions cost hence it is better to supply herself. And for the household as consumer, the shadow price is lower than the market price hence it is better to buy from herself. Hence, if nonseparation of food production and consumption is verified, imputing regional wholesale prices for self-produced food leads to undervaluation.

Table 1 Ratio of calorie intake and food liras of household food consumption

Definition	All sample		Urban		Rural	
	Calories %	Food liras %	Calories %	Food liras %	Calories %	Food liras %
1- Purchased	91.0	92.0	97.2	96.1	79.6	82.3
2- Self-produced food	7.0	4.8	0.5	0.5	18.8	14.9
3- Produced for market but consumed in the household	1.1	1.0	1.2	1.0	1.0	1.1
4- Payments in kind by employer	0.3	0.2	0.4	0.3	0.1	0.1
5- Purchased for the purpose of donation	1.6	2.0	0.7	2.1	0.5	1.6

Two characteristics about self-produced food stand out in particular. First, self-produced food is more prevalent in several commodities, while it is virtually non-existent for others. On the one hand, there are no self-produced highly processed products such as sugar and vegetable oils. On the other hand, 60% of fluid milk, 76% of yogurt, 70% of butter, 40% of cheese, 27% of eggs, 36% of other grain products, and roughly 15% of fruits and vegetables consumed in rural areas are self-produced (percentages calculated in caloric terms). These initial observations suggest that for some rural households, production and consumption decisions might not be separable. Second, retail and imputed price differentials vary across products. For dairy products, the imputed price is roughly 74% of retail price. In the "other grains" category, the imputed price is 70% of rural retail prices. For fruits and vegetables, the imputed prices are roughly 66% of retail prices. However, for products that have highly industrialized alternatives, such as poultry and eggs, retail prices are lower than imputed prices.

Table 2 shows the percentage of non-zero purchases and summary statistics for the food budget share of each food group. Table 3 presents similar statistics for the self-produced products. In light of the demonstrated concentration of self-produced food in certain animal products, I group food items slightly differently than Akbay et al. (2007, 2008) did. The authors classify butter with fats and oils, and eggs under the category of "other foods". Here, I classify dairy products, butter and eggs together, while I keep Akbay et al.'s classification for the rest of the items. I hold that butter and eggs display more characteristics common with cheese and yogurt than with vegetable oils or highly processed food products (in the "other food" category) for rural households because of butter and eggs are among the most prevalent self-produced food items.

5 Empirical results

5.1 Testing separability

The SIS (2003) survey is designed to be representative at the country level and a stratified multi-stage systematic cluster sampling method is used in data collection.

Table 2 Percentage of non-zero purchases, mean food expenditure shares and monthly spending

Food groups	Households purchasing (%)	Mean exp. share (%)	Mean exp. by all households (TL[b]/month)	Mean exp by purchasing households (TL/month)
Bread[a]	94.9	15.8	27.6	29.1
Cereals[a]	94.8	9.1	18.4	19.4
Meat and meat products[a]	89.8	13.6	34.3	38.2
Vegetable oils	83.1	5.7	11.3	13.6
Vegetables[a]	99.7	16.9	32.0	32.1
Fruits[a]	97.7	9.1	17.8	18.2
Dairy products and egg	99.3	15.1	28.5	28.7
Sugar, confectionary and jams[a]	94.7	7.9	15.9	16.8
Tea and coffee[a]	76.3	3.0	5.6	7.3
Non-alcoholic beverages[a]	72.1	2.7	5.3	7.3
Other food products	66.6	1.2	2.4	3.6

[a] Same as Akbay et al. (2007), Table 3

[b] *TL* Turkish Lira. The average exchange rate for 2003 is 1.5 TL for $1 at current prices, and 0.732 TL for $1 at PPP

Table 3 Percentage of own-producing households and share of self-produced food in total consumption of each food group

Food groups[a]	Entire sample		Urban only		Rural only	
	Own-producing. % of hhs	Share of own-prod. in consumption (%)	Own producing % of hhs	Share of own prod. in consumption (%)	Own-producing % of hhs	Share of own-prod. in consumption (%)
Cereals[b]	8.2	5.6	0.5	0.3	27.0	18.5
Meat	1.4	0.9	0.2	0.1	4.3	2.9
Vegetables	9.0	3.1	1.9	0.6	26.3	9.2
Fruits	3.9	2.1	0.9	0.4	11.3	6.1
Dairy and egg	14.9	12.0	1.7	1.0	47.2	38.7
Sugar etc.	0.5	0.3	0.1	0.1	1.5	1.0
Tea and coffee	0.1	0.1	0.0	0.0	0.4	0.4

[a] There is no self-produced food of bread, vegetable oils, non-alcoholic beverages and other food groups

[b] Cereals includes other grain products which in turn include flour used for making bread at home

Table 4 Wald test whether all of the self-produced food variables are jointly equal to zero

Wald test	Sample	DF	Chi^2	Critical value (0.05)	Prob >Chi^2
Self-produced food budget share	Whole	10	5,324.8	18.3	0.00
Self-produced food budget share	Urban	10	505.9	18.3	0.00
Self-produced food budget share	Rural	10	3,261.3	18.3	0.00
Self-produced food and interaction terms	Whole	30	5,715.7	43.8	0.00
Self-produced food and interaction terms	Urban	30	659.5	43.8	0.00
Self-produced food and interaction terms	Rural	30	3,634.5	43.8	0.00

The survey covered a sample of 25,764[12] households from 12 regions without replacement, and was conducted over 12 months from January 1 to December 31, 2003 in order to minimize seasonal influences on consumption. The survey includes detailed demographic characteristics for each household that allow for controlling for heterogeneity in preferences.[13]

Construction of food groups, especially of animal products, differently than Akbay et al. (2007) caused some drop in the share of non-zero purchases in the fats and oils category [from 86.2% in Akbay et al. (2007) to 83.1% here]; a significant drop in the share of non-zero purchases in the "other food" category (from 95.8 to 66.6%); and an increase in the share of non-zero purchases in the dairy products and eggs category (from 97.7 to 99.3%). Hence, the model I utilize yields different results from those of Akbay et al. (2007). The difference is most pronounced for elasticity estimates for the "other food" group where the change in non-zero purchases due to different categorization is greatest.

First, I test whether the addition of the food budget share of self-produced food to the demand system is jointly significant.[14] Table 4 presents Wald tests results for various specifications. The null hypothesis is that all self-produced food budget share coefficients are equal to zero in the demand system. The results of Wald tests invariably show that self-produced food budget share coefficients are significant, and thus the null hypothesis is rejected.

The first three rows in Table 4 tabulate the results of specifications that employ only self-produced food budget share as an instrument (Eq. 2). Wald test results reject the null hypothesis; the coefficients of self-produced food are statistically significant. Although I tried alternative specifications with different definitions[15] of self-produced

[12] Table A1 (see Electronic Supplementary Material) in Tekguc (2010) presents the summary statistics for all the variables used in the model. There is no detail of food consumption for 17 households, so I conducted empirical tests with 25,747 observations.

[13] Summary statistics are available in Tekguc (2010) (Table A1—see Electronic Supplementary Material).

[14] The coefficients of budget share of self-produced food are significant in all of eleven food groups at the 1% significance level or less. The coefficient estimates from Eqs. 1, 2, and 3 are presented in Tables A3, A4 and A5 (see Electronic Supplementary Material) in Tekguc (2010).

[15] Alternative definitions include self-produced food budget share of each food group in the respective equation, instead of the average of self-produced food. In another case, I broaden the content of self-produced food and include the categories three and four as defined in Table 1. Finally, I calculate and use

food budget share, I am only presenting the results for self-produced food budget share since this finding is robust across specifications. In the last three rows, I include interaction variables of self-produced food budget share with food expenditure and prices in addition to self-produced food budget share (Eq. 3). The conclusion is still the same: Wald test shows that the coefficients are jointly significant.[16]

5.2 Elasticity estimates when self-produced food budget share and interaction variables included

In the previous section I showed that the inclusion of self-produced food budget share as an instrument in the standard AIDS model improves the model significantly. However, statistical significance does not necessarily equal to economic significance. Hence, in this section, I compare the elasticity estimates from the 'standard' model (Eq. 1) with the elasticity estimates from the 'extended' model that includes self-produced food budget share and the interaction terms with price and food expenditure (Eq. 3).

I expect that the inclusion of self-produced food budget share and the interaction terms would have the most pronounced effect on the elasticity estimates of dairy products and eggs and cereals groups since self-produced food consumption is the most prevalent in these categories. Following the previous work on AHM, I also expect that the standard AIDS model that ignores self-produced food consumption to lead over-estimation.

Tables 5 and 6 present food expenditure and uncompensated own-price elasticities for both models. All the individual elasticity estimates are statistically significant for both models. The estimates for which the difference between the models is statistically significant are highlighted. All the significant differences point to over-estimation in standard model (Eq. 1). For food expenditure elasticities, only the estimate for dairy products and eggs category differs significantly when interaction terms are included[17] both for the whole sample and rural areas. This follows from the fact that only the share of self-produced dairy products and eggs products are over 10% country-wide (38.7% in rural areas). For uncompensated own-price elasticities, only significant differences between two models are seen in the estimates for bread and cereals consumption in the whole sample and in rural areas (in rural areas 18.5% of cereal consumption is from self-produced food). Even though there is no self-produced bread in this data set, cereals category includes flour from self-produced grains, which is likely to indirectly affect the price

Footnote 15 continued
the predicted values for self-produced food as instruments instead of sample observations in order to control for measurement errors. The results of these additional tests are in Tekguc (2010) (Table A2—see Electronic Supplementary Material).

16 I also performed likelihood ratio tests where the usual AIDS model is nested into the model including self-produced food budget share. The results of these tests also show that including variables into the model makes it significantly different than standard model. The results of likelihood ratio tests are available upon request.

17 I use t stat $= (b_I - b_{II})/(S_I^2 + S_{II}^2)^{0.5}$ formula to test whether the differences between estimates are statistically significant.

Table 5 Food expenditure elasticities for Eqs. 1 and 3

Food groups	All sample		Urban		Rural	
	Eq. 1	Eq. 3	Eq. 1	Eq. 3	Eq. 1	Eq. 3
Bread	0.65	0.65	0.69	0.69	0.55	0.52
	0.01	0.01	0.01	0.01	0.02	0.03
Cereals	1.10	1.08	1.09	1.08	1.15	1.11
	0.01	0.01	0.02	0.02	0.02	0.02
Meat and meat products	1.76	1.75	1.68	1.68	1.86	1.89
	0.01	0.01	0.01	0.01	0.02	0.03
Vegetable oils	1.16	1.17	1.20	1.21	1.03	1.05
	0.02	0.02	0.02	0.02	0.03	0.03
Vegetables	0.87	0.87	0.90	0.90	0.85	0.83
	0.01	0.01	0.01	0.01	0.01	0.01
Fruits	0.82	0.81	0.86	0.86	0.73	0.71
	0.01	0.01	0.01	0.01	0.02	0.02
Dairy products and egg	**0.82*** **	**0.78*** **	0.80	0.79	**0.90*** **	**0.75*** **
	0.01	**0.01**	0.01	0.01	0.02	0.02
Sugar, confectionary and jams	1.08	1.07	1.07	1.07	1.10	1.08
	0.01	0.01	0.01	0.01	0.02	0.03
Tea and coffee	0.77	0.79	0.87	0.87	0.60	0.59
	0.02	0.02	0.02	0.02	0.03	0.03
Non-alcoholic beverages	0.76	0.76	0.75	0.76	0.69	0.72
	0.02	0.02	0.02	0.02	0.04	0.04
Other food products	0.92	0.92	0.88	0.88	0.84	0.87
	0.02	0.02	0.03	0.03	0.05	0.05

All the individual elasticity estimates are statistically significant for both models

*** The difference between Eqs. 1 and 3 estimates are statistically significant at 1%

elasticity of bread. Contrary to my expectation, the own-price elasticity of dairy products and eggs group is not affected by the inclusion of interaction terms. The urban food expenditure and own price elasticity estimates are practically same for both models in urban areas and self-produced food accounts for a very small share of total consumption in urban areas in every food category.[18]

6 Concluding remarks

Consumption of animal products is of particular importance for Turkish policy makers. A panel put together by State Planning Institute (OIK 2006) concluded that

[18] Cross-price elasticities are presented in Table A6 (see Electronic Supplementary Material) in Tekguc (2010). Most of the cross-price elasticities are insignificant both in Eqs. 1 and 3. The addition of interaction of prices and self-produced food share (Eq. 3) generally cause some decline in absolute values of cross-price elasticities. The cross price elasticities that show the biggest change are in bold characters.

Table 6 Own-price elasticities for Eqs. 1 and 3

Food groups	All sample		Urban		Rural	
	Eq. 1	Eq. 3	Eq. 1	Eq. 3	Eq. 1	Eq. 3
Bread	**−0.89***	**−0.86***	−0.80	−0.80	**−1.04***	**−0.99***
	0.01	0.01	0.01	0.01	0.02	0.02
Cereals	**−0.84***	**−0.81***	−0.69	−0.69	**−1.06***	**−1.01***
	0.01	0.01	0.01	0.01	0.02	0.02
Meat and meat products	−0.75	−0.76	−0.79	−0.79	−0.74	−0.73
	0.01	0.01	0.01	0.01	0.02	0.02
Vegetable oils	−0.93	−0.92	−0.81	−0.81	−1.21	−1.19
	0.02	0.02	0.02	0.02	0.04	0.04
Vegetables	−0.77	−0.78	−0.77	−0.77	−0.80	−0.80
	0.01	0.01	0.01	0.01	0.02	0.02
Fruits	−0.80	−0.80	−0.80	−0.80	−0.79	−0.80
	0.01	0.01	0.01	0.01	0.02	0.02
Dairy products and egg	−0.74	−0.74	−0.75	−0.75	−0.75	−0.74
	0.01	0.01	0.01	0.01	0.01	0.01
Sugar, confectionary and jams	−0.71	−0.71	−0.69	−0.70	−0.73	−0.74
	0.01	0.01	0.01	0.01	0.02	0.02
Tea and coffee	−0.89	−0.89	−0.91	−0.91	−0.84	−0.80
	0.01	0.01	0.01	0.01	0.03	0.03
Non-alcoholic beverages	−1.09	−1.09	−1.08	−1.08	−1.08	−1.10
	0.01	0.01	0.01	0.01	0.03	0.04
Other food products	−0.81	−0.81	−0.79	−0.79	−0.83	−0.83
	0.01	0.01	0.01	0.01	0.02	0.02

All the individual elasticity estimates are statistically significant for both models

* The difference between Eqs. 1 and 3 estimates are statistically significant at 10%

Turkey is short of animal products, and that Turkish consumers are at risk of under-consuming animal-sourced calories and proteins. The report produced by this panel strongly advocates reforms to modernize the animal husbandry sector in order to boost domestic supply. However, independent researchers like FAO (2001), Pekcan and Karaağaoğlu (2000), Sengul and Tuncer (2005), and Akbay et al. (2007) all agree that there is no shortage of food supply in Turkey, but rather the nutrition problem is rooted in the mal-distribution of food. If the policy goal is to ensure sufficient availability of animal calories, then ignoring the nonseparation of production and consumption decisions in rural households becomes more serious than just the issue of over-estimation of elasticities. Since self-produced animal products are especially crucial for rural areas where overall poverty is more severe (Sengul and Tuncer 2005), ignoring the nonseparation of consumption and production decisions is a particularly costly mistake from a nutritional perspective.

Given the interest of Turkish policymakers in increasing animal products consumption, I present evidence that certain self-produced food groups account for a significant portion of rural households' food baskets in Turkey. Following the framework outlined by Benjamin (1992), I test and reject the null hypothesis of separation, and conclude that the production and consumption decisions are nonseparable for rural households in Turkey. Inspired by the technique used by Hoddinott and Haddad (1995) in testing for differential effects of male and female incomes on household consumption, I employ the budget share of self-produced food (and alternative versions) as a means to test the separation hypothesis. If decisions to produce and consume are indeed separable, then the budget share of self-produced food should not influence the households' consumption decisions. In the presence of well-functioning markets and separable production and consumption decisions, the household treats itself as any other retail outlet, i.e. the existence of an in-house supermarket should not affect the decisions about budget shares of different food groups. The empirical tests, however, reveal that separation is not the case for rural Turkey.

After showing that the implicit separation of production and consumption assumption does not hold for Turkey, I study this finding's implications from a policy standpoint. Since I held that the budget share of self-produced food is a rather blunt instrument, I interact this term with price and food expenditure variables in order to obtain more nuanced estimates. I show that the expenditure elasticity estimate for dairy products and eggs category is overestimated when separation is assumed (i.e. in the model without interaction terms) especially for rural areas. For own-prices, elasticity estimates are overestimated for cereals and breads, although the differences are significant only at 10%.

Empirical tests of AHM requires very detailed data both on household characteristics to control for the heterogeneity of households and on production decisions of rural households including the productive assets owned and allocation among possible uses. For this reason, most empirical applications of these models utilize small samples drawn from village settings. Given these circumstances, I develop a second-best approach to test some of the central insights of AHM by using a country-level dataset. This approach is suitable for dealing with such large datasets as long as the share of the self-produced food budget can be extracted and used in testing the implicit assumption of separation of consumption and production decisions. I also derive the elasticity formulas when interaction terms are included in the model and recalculate elasticity estimates in order to check whether the empirical findings have economic significance in addition to statistical significance. Finally, I hope that this paper will be useful for researchers focusing on other middle income countries where self-produced food consumption in rural areas is significant while the majority of households are price-takers.

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